The FOUNDRY

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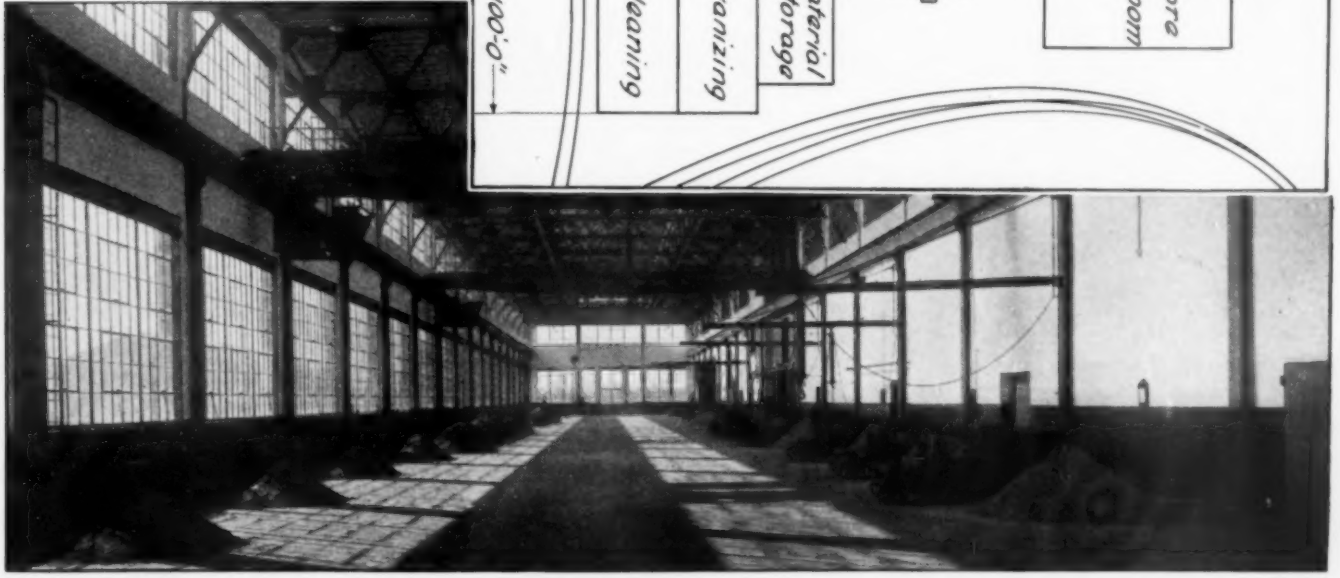
Handling Expedited in New Foundry

Electrically Controlled Cars for Raw Materials, Storage Battery Lift-Trucks for Ladles and a Monorail System Speed Operations In Modern New England Shop

BY H. R. SIMONDS

REFLECTING the exhaustive experience of experts, a modern foundry has just been put in operation by Gilbert & Barker Mfg. Co., Springfield, Mass., maker of gasoline and oil pumps and storage tanks. The plant was built through necessity as the company was reluctant to enter into the foundry field. Previous to opening the new foundry, castings were secured from more than 20 different plants scattered throughout New England. Although the casting requirements of the plant at present amount to approximately 25 tons a day, the new foundry is designed for 100 tons a day and the cupola capacity is approximately 30 tons per hour. The general layout of the foundry is shown in Fig. 2. The main foundry is 60 feet x 400 feet and 32 feet in height to the bottom of the roof trusses. As shown in Fig. 1 the lighting is exceptionally good and the floor area is larger than actually necessary for producing 100 tons of castings per day. The building is of brick and steel on a concrete foundation. The office extends across one end of the main foundry floor, and the superintendent's private office is elevated so that it commands a view of the entire foundry. The two cupolas have the usual location at the center and to one side



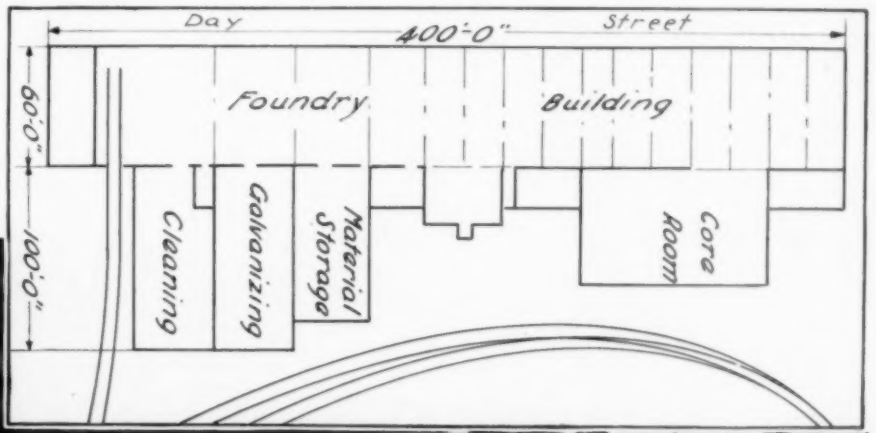
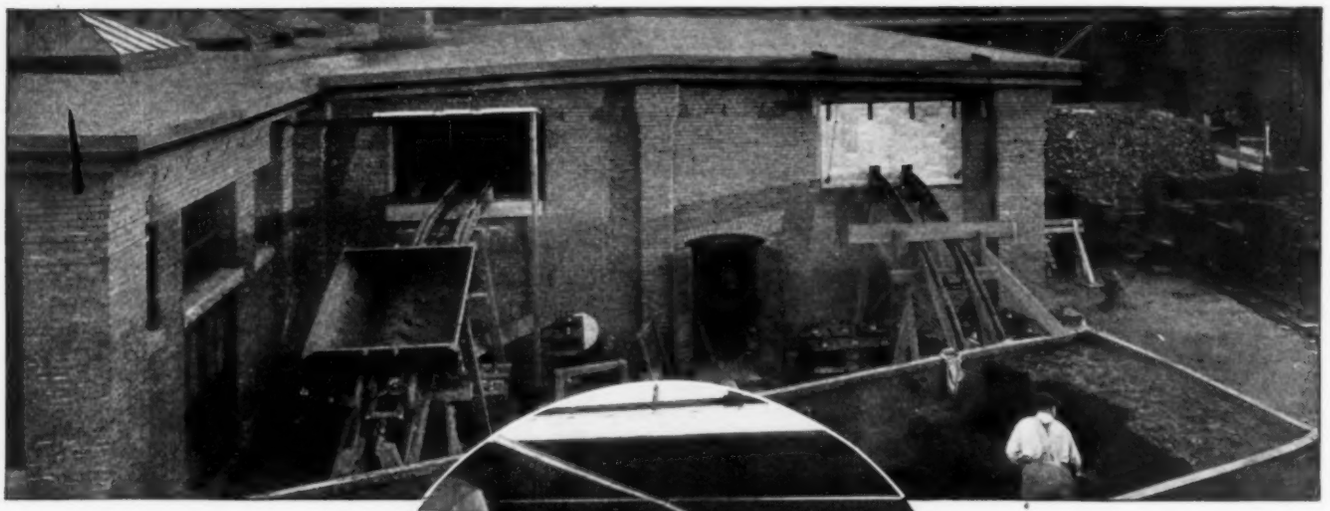


FIG. 1—THE FOUNDRY IS WELL LIGHTED AND HAS AN UNUSUAL APPEARANCE OF AMPLE ROOM FIG. 2—FLOOR PLAN OF THE FOUNDRY SHOWING ITS RELATION TO THE PLANT



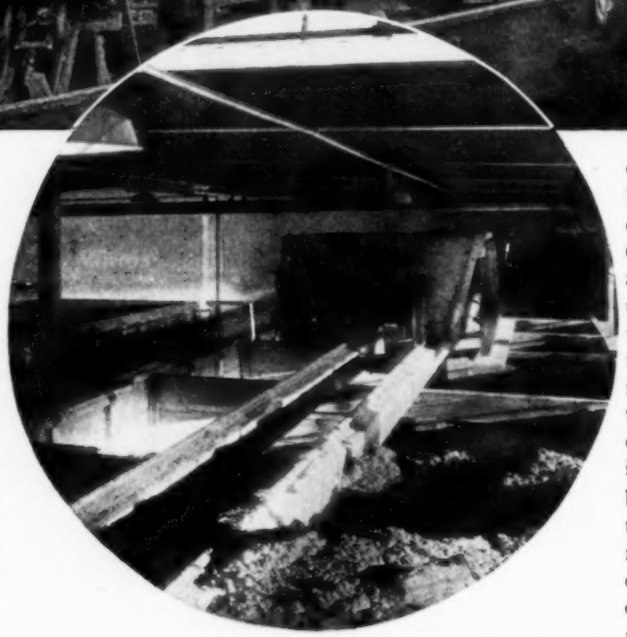


FIG. 3 (ABOVE)—SAND IS UNLOADED DIRECTLY FROM THE CARS INTO THE HOPPER BOTTOM CARTS WHICH ARE HAULED UP OVER THE STORAGE BINS AND DUMPED. FIG. 4 (BELOW)—THIS SHOWS THE TOP OF THE STORAGE BINS WITH THE TWO DUMP DOORS, ONE ON EACH SIDE OF THE CAR

of the foundry floor. Each is 50 feet 11 inches high, and one is 78 inches outside diameter and the other 90 inches. The foundry is equipped with two overhead traveling cranes, one of 10-ton and the other of 5 ton capacity, which operate over the entire floor area. Four wall cranes each having a 20-foot operating radius and being equipped with a 1-ton air hoist, are spaced along the inner wall of the foundry to serve the section devoted to larger castings. Combination jolt and squeeze molding machines are distributed along the outer wall of the foundry and portable job roll-over pattern draw machines are provided for the heavier work along the inner wall. In all, there are present 52 molding machines in the plant, with additional space for more if required.

As will be seen from the plan, the core room is located near one end of the foundry. The cupolas and wash rooms occupy the center section and at the other end are the cleaning and galvanizing departments and the sand storage and treating room. The plant is provided with its own standard-gage track system and switch engine so that material can be delivered to the foundry doors; in fact, one spur runs directly onto the foundry floor so that castings may be loaded with a minimum of handling.

Sand is brought on cars to a point opposite the sand storage bins and is taken directly from the cars in small cable operated dump carts up over the bins and dumped wherever desired. This is clearly shown in Figs. 3 and 4. Fig. 3 shows the small dump cart descending the incline to receive the load. It is electrically operated and its movement and its unloading action are controlled by push buttons. Fig. 4 shows a cart with the two side dump doors on tracks. The control is such that an operator standing on the floor level is able to dump the carts in any bin desired.

The coke and pig iron storage yard is located between the tracks and the cupola tower, as shown in Fig. 5. This illustration also gives an idea of the foundry construction. The switch engine used throughout the plant is shown at the right. The coke and pig iron are conveyed in small carts directly from the yard onto an elevator in the cupola tower and from the elevator are rolled off on the charging floor as shown in Fig. 6.

A space of about 40 feet at the southern end of the foundry floor is devoted to brass and alloy casting and adjacent to this in a separate room are located two brass melting furnaces. The core room, which is 100 feet x 60 feet, is well equipped with ovens, benches, and sand treating apparatus. There are seven car-type ovens, each 15 x 8 x 6 feet high, and seven drawer type ovens each having five drawers, 60 x 17 inches. All furnaces are oil-fired, and the car-type units are provided with through tracks so that cores may be taken out directly onto the foundry floor. Each of the car-type ovens accommodates two cars of the design shown in the illustrations. Fig. 7 shows both banks of ovens. In the drawer type ovens, each drawer is arranged so that it may be clamped independent of the others to an overhead trolley support and thus any number of drawers may be drawn out from each oven as desired.

The plan of the foundry has been arranged so as to give as nearly a continuous flow of material as possible throughout the various processes of manufacture. Raw material goes direct from the yard to the cupolas, and the molten metal is taken to the molding floors. The castings are taken to the cleaning room at the north end of the foundry after which they are taken into the galvanizing room, which is adjacent to the cleaning room.

Unusual care has been given to the design of the galvanizing department. Two complete galvanizing batteries extend along opposite sides of the room, as shown in Fig. 8. The castings are brought in at the left, are placed in wooden containers and then transported by means of an overhead monorail system to the tanks as required. The traveler mechanism is the first of its type to be built. It is motor propelled and the double hoist blocks are raised and lowered by a second motor. All movements are controlled from the floor. Track switches are chain controlled and equipped so that when open the circuit is automatically broken to prevent cars from running off track.

The wood block floor throughout the plant provides means for an excellent transportation system. Small, battery-operated, lift-trucks are used for practically all transporting of materials. The iron from the cupolas is caught in large ladles which are carried on portable supporting stands similar to that shown in Fig. 10. Even while the ladle is filling, it is possible for the lift truck to run in under the ladle support, lift the entire device and thus be ready to carry off the metal as soon as it has reached the desired level in the ladle. These trucks carry the large ladles to all parts of the foundry as desired. The iron from the large ladles is poured by means of a hand-operated pouring mechanism into small ladles for filling the small molds or into larger ladles for heavier work. Fig. 10 shows an individual molding floor. Near the windows is the molder with his molding machine, and at his left is a small table on which cores and parts of flasks or patterns may be placed. The machine operator is responsible only for making the molds and setting them on the floor. Members of a pouring gang fill the molds and the men of a second group collect the castings. The pouring is continuous and is carried on sufficiently rapidly to prevent a large accumulation of molds on molding floors. This practice makes it possible to obtain a large output with a minimum of floor area. The molding machines are close together and the pouring gang is expected to reach each molder's floor before more than 15 or 20 molds have accumulated.

The wood block floor is specially treated to guard against burning, but it would be unwise to establish a practice of dumping hot castings from the molds directly onto the floor. Therefore a method of collecting castings has been devised which prevents this contact of castings with the floor and also provides an efficient means of transporting the finished product. Iron grid boxes with legs high enough to hold them in position for the lift trucks are carried to the molding floors as desired. In the case of small work the molds are dumped into these grids and when full they are collected by the trucks and carried to the finishing room. For larger work a slightly different scheme of operation is necessary.

System Is Flexible

The roll-over molding machines are portable, and it is possible for the molder to follow the sand heap. Moreover, the machines can be shifted from one molding floor to another, and by means of a quick plate changing arrangement, can be quickly put on new work as conditions may require. This scheme, the superintendent believes, has not been tried out in any other foundry before. It is essentially a plan to prevent expensive equipment remaining idle while some other link in the sequence of operation is completed. For instance, if a molder on one machine who is making a cope gets far ahead of the drag mold operation on another machine, his machine is taken bodily from his floor and moved to another floor, a new plate attached, and a new job started. On the larger work the specialization is carried further than on the small molding machines. The usual arrangement is to have two molders and two machines making the cope and drag respectively and then to have a finishing gang place the cores and complete the molds, with the pouring and collecting gang following, as already outlined.

The foundry has just been put into operation and many plans of the superintendent are still to be developed. Thus far the lift truck method of transportation has proved remarkably successful and when further work in connection with the design of boxes and platforms has been carried out, it is expected to provide an even more perfect system of handling foundry materials. One scheme under development provides for an interchangeable box platform. A standard platform of sturdy design, 8 or 10 feet long by about 4 feet wide, high enough to clear the lift truck will be built. Then box sides of varying heights will be made to fit on to this stand-

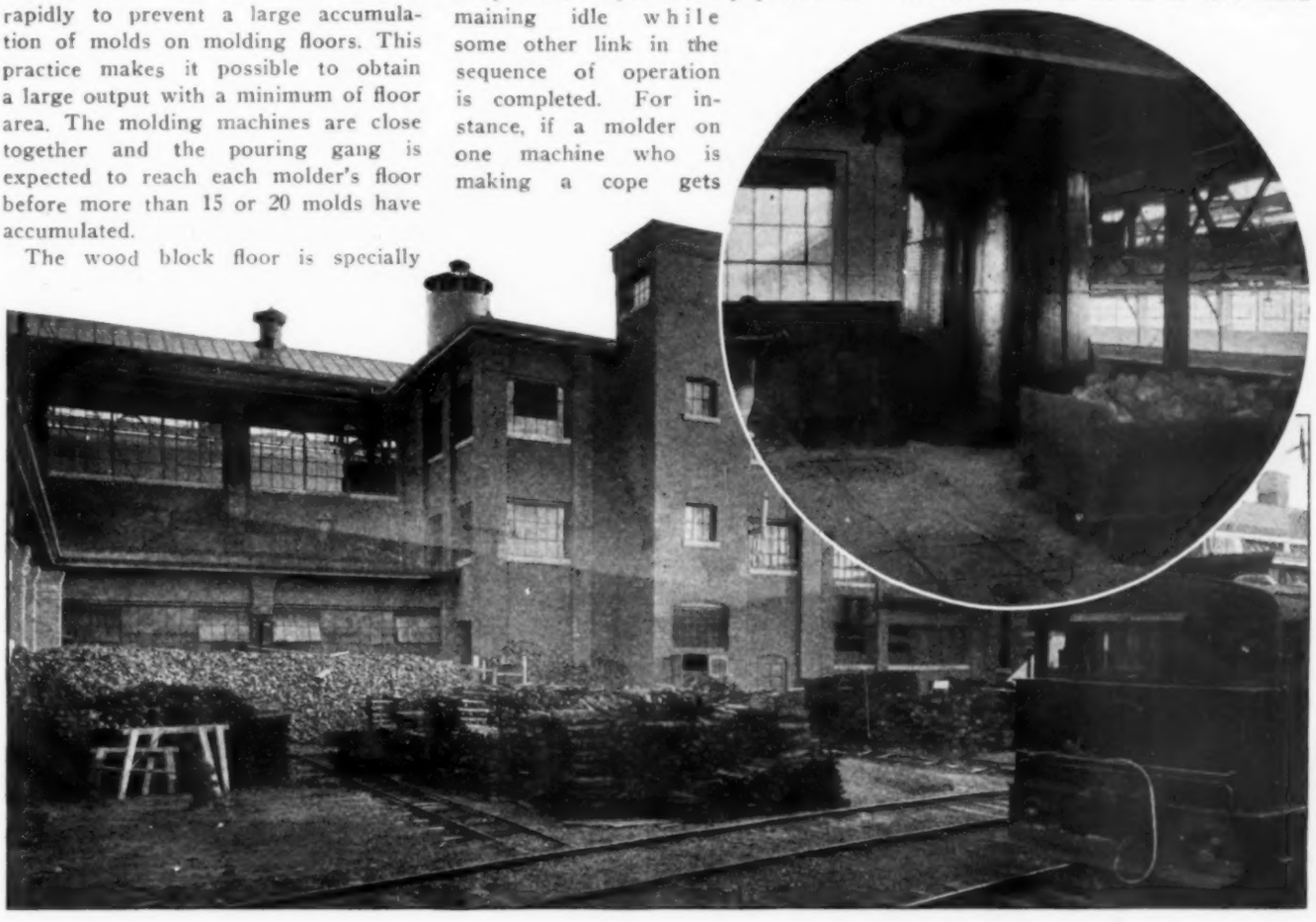


FIG. 5 (BELOW)—THE PIG IRON AND COKE STORAGE YARDS LIE IN A CONVENIENT SPACE BETWEEN THE STANDARD GAGE TRACKS AND BACK OF THE FOUNDRY. FIG. 6 (ABOVE)—MATERIAL FOR THE STORAGE YARD IS LOADED ON SMALL CARTS AND THEN LIFTED ON AN ELEVATOR TO THE CHARGING FLOOR

FIG. 7—THERE ARE SEVEN CAR TYPE AND SEVEN DRAWER TYPE CORE OVENS CONVENIENTLY LOCATED BETWEEN THE CORE ROOM AND FOUNDRY

ard platform. When heavy castings are to be transported, the bare platform will be used and when sand or small castings or other materials is to be carried, the different sizes of box sides will be set in place.

Wood block flooring is employed in many foundries, but its use in the Springfield plant is more extensive than usual. Except for a space of 15 or 20 feet in front of the cupolas where a thin layer of sand about half an inch thick is spread, no precautions are deemed necessary to guard against the spattering of metal. Molten metal direct from the ladle may be poured on the floor and if scooped up within a short space of time it will do no damage whatever. In case a spot is burned in a floor, it is a simple job to repave the burned area with new blocks.

The foundry superintendent is S. Griffith, and the officers of the Gilbert & Barker Manufacturing Co. are as follows; President, R. H. McNall; vice president, C. C. Ramsdell; treasurer, W. T. Rayner; and assistant treasurer, W. H. Wood.

Purchase British Rights To Sand Thrower

Completion of negotiations conducted by J. F. Janes, Cleveland, has

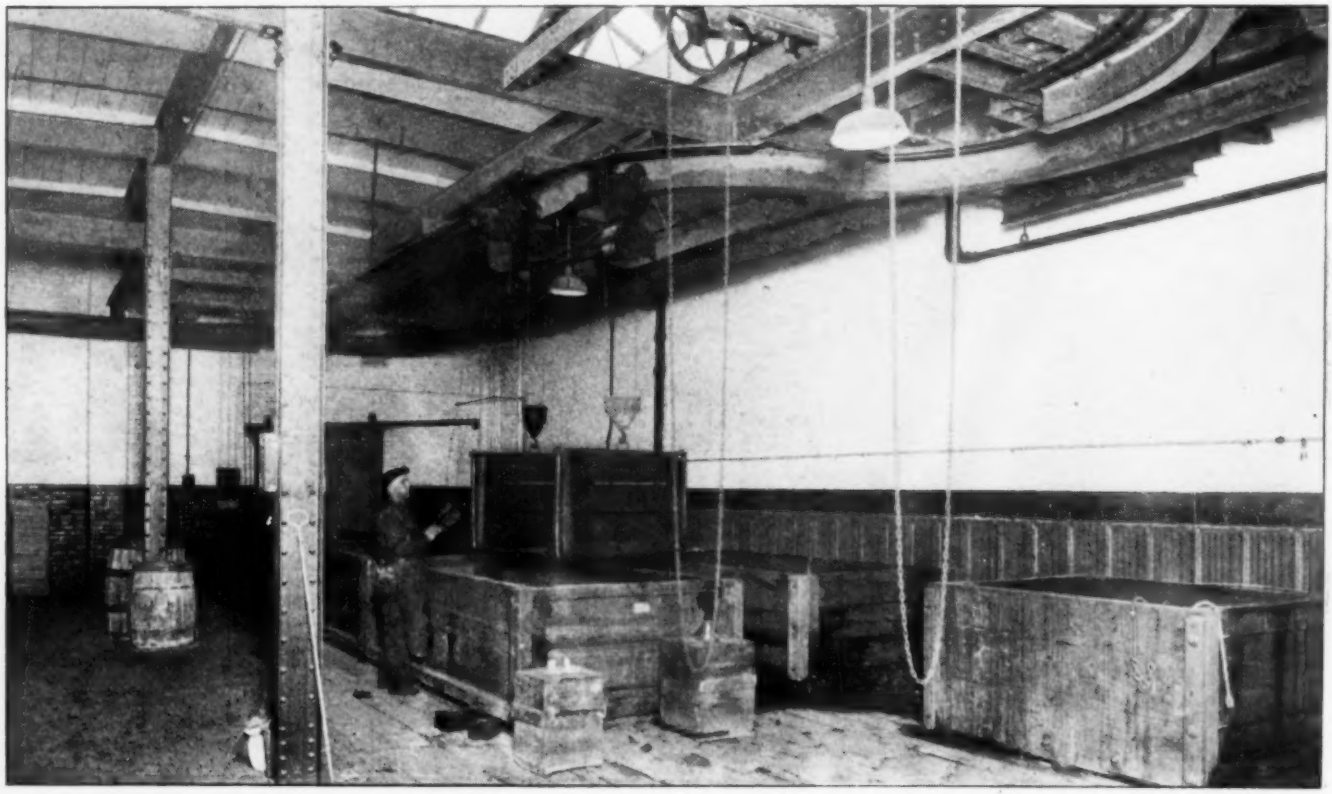


FIG. 8—A CORNER OF THE GALVANIZING ROOM SHOWING THE OVERHEAD MONORAIL SYSTEM WITH A SELF-PROPELLED MONORAIL CARRIER

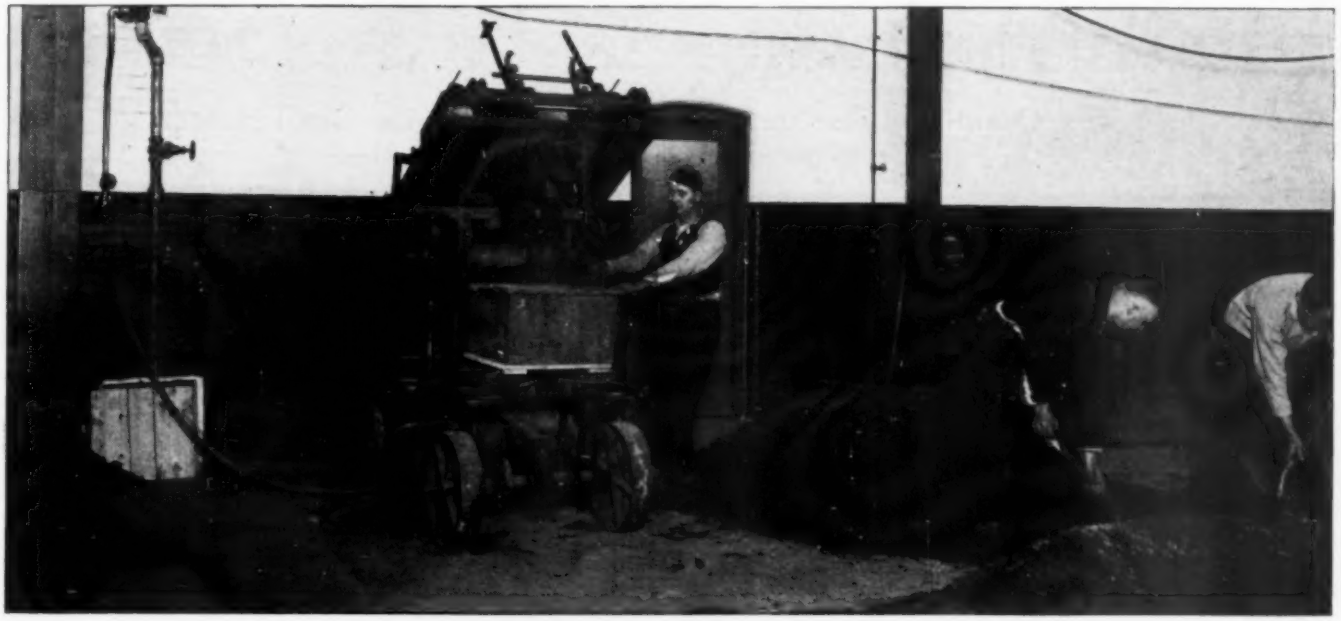


FIG. 9—FOR THE LARGER WORK PORTABLE ROLL-OVER MACHINES ARE USED

resulted in the purchase of the British rights to the Beardsley & Piper sand throwing machine by a newly formed corporation under the name of the Foundry Plant & Machinery Co., 28 Royal Exchange, Glasgow, Scotland. Following the publication of the first description of the sand throwing machine, in THE FOUNDRY, in August, 1919, keen interest has existed abroad. After preliminary negotiations between the National Light Castings Association of Great Britain, three members were sent to this country to see the machine in operation. The plants visited by this deputation included those of the Standard Sanitary Mfg. Co., Pittsburgh, International Harvester Co., Chicago, Rundle Mfg. Co., Milwaukee, and the American Radiator Co., Buffalo.

The new Foundry Plant & Machinery Co. is capitalized at £100,000. Norman Cockburn, M. Cockburn & Co., Ltd., Falkirk, Scotland is one of the British foundrymen prominently identified with perfecting the arrangements. Beardsley & Piper, Chicago, are the largest individual stockholders in the new company. The others who are interested all are members of the National Light Castings Association. Daniel Sharpe is manager of the company.

The British company will market four types of machines, including the tractor, and stationary models, truck machines for jobbing foundries and a bench machine for small light work.

FIG. 10—THE MOLTEN IRON IN LARGE LADLES IS TRANSPORTED BY LIFT TRUCKS DIRECTLY TO THE MOLDING FLOOR

Install Giant Cupola To Meet Need

Increased Quantity of Hot Metal Demanded by Large Castings Induced Eastern Foundry to Seek Super-Furnace—How Turbine Runners Are Molded

BY E. C. KREUTZBERG

FOR many years the I. P. Morris foundries of the Wm. Cramp & Sons Ship & Engine Building Co., Philadelphia, have specialized in the production of castings for water turbines. In the early days, when only the most desirable power sites were developed, these units were comparatively small. The development of the shallower heads of late has necessitated the use of much larger turbines than those formerly employed, so that problems recently have arisen in connection with the production of the heavier castings involved.

Heaviest of the castings in a water turbine is the turbine runner. This is the wheel the vanes of which receive the impact of the falling water thus causing the runner to rotate turning a shaft driving the power unit. One of these runners just cast at the I. P. Morris foundries weighed 93,000 pounds after being finished. Larger castings already are in sight. In fact, specifications for one unit in connection with a water power development soon to be undertaken calls for a turbine runner to weigh 160,000 pounds.

When the order for the 93,000-pound turbine runner was received the I. P. Morris iron foundry cupola equipment consisted of two units. One of them had a rated capacity of 22,000 pounds of molten iron per hour, and the capacity of the other was 15,000 pounds. For pouring the casting, as later events showed, 116,000 pounds of metal were required. With this equipment a lapse of nearly five hours intervened between tapping the first iron and pouring the mold.

For pouring the 93,000-pound turbine runner, George E. Matlack, superintendent of the I. P. Morris foundries, feared to rely on this melting equipment. The turbine runner is an unusual casting. In use, it must have the greatest delicacy of balance. It must be cast with the weight uniformly distributed. Mr. Matlack feared that harmful strains and stresses would result if he cast it with metal that had been drawn from the cupolas over a period of several hours; some of it would be of maximum temperature while some would have cooled off to near the freezing point.

Therefore, steps were taken for the immediate installation of a cupola which alone would have capacity for producing molten metal at the rate desired. This cupola was ordered last July and the first 93,000-pound turbine runner was cast from it the latter part of October. It is a giant of its kind. It produces 14,000 pounds of molten metal every 15 minutes, or 56,000 pounds per hour. He says furthur that a furnace of this size is no plaything, and it is highly unsafe to put it in operation before the mold, the cranes, the ladles and the other equipment have been placed in readiness for the disposal of the iron as fast as it is produced. In charging this cupola, says Mr. Matlack 5200 pounds of coke are placed on the bed and 6000 pounds of pig iron. Thereafter coke and pig iron are added in the ratio of 1 to 10, the succeeding charges being 600 pounds of coke and 6000 pounds of pig iron.

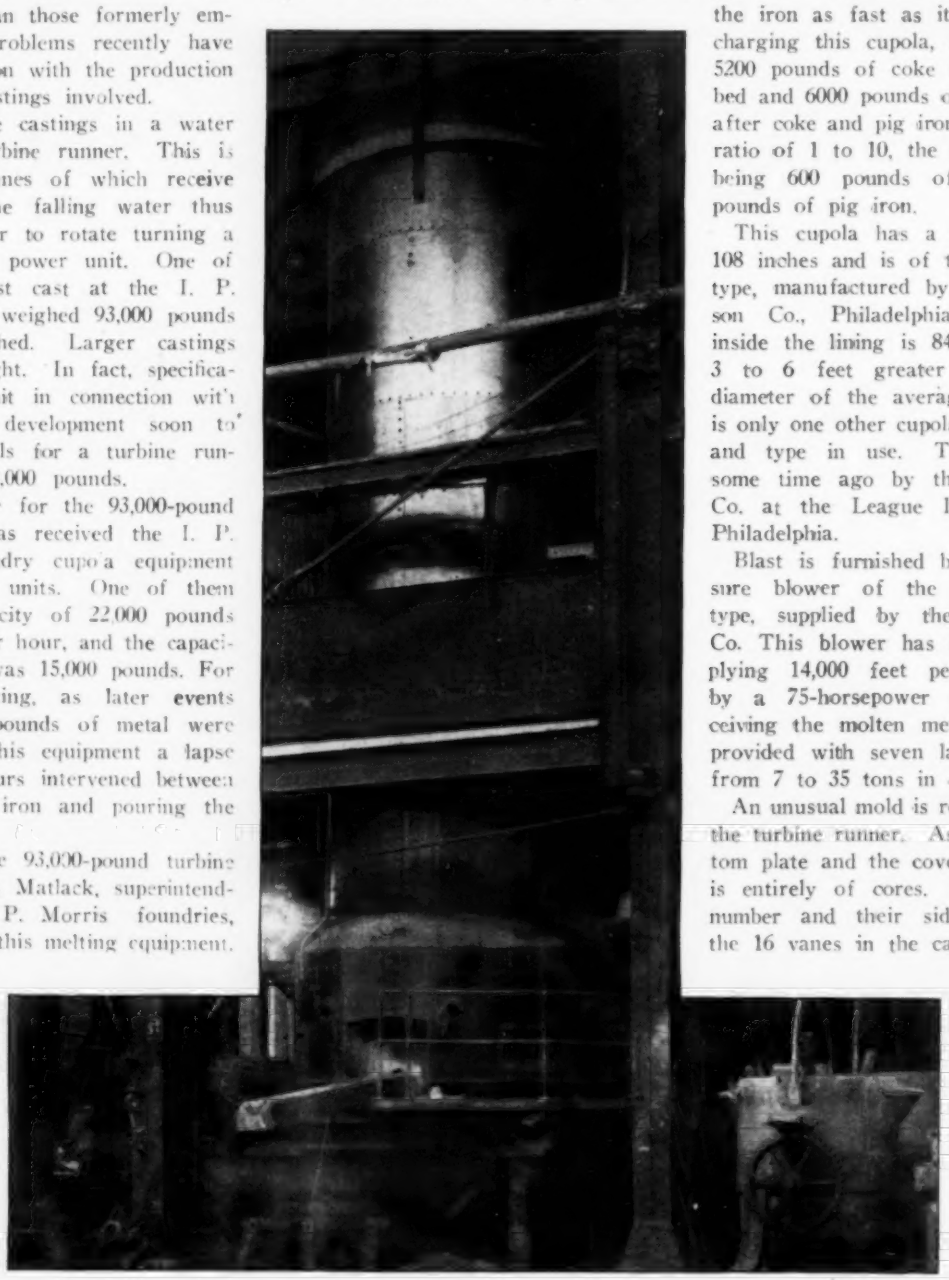


FIG. 1—THE CUPOLA HAS A SHELL DIAMETER OF 108 INCHES LINED TO 84 INCHES

This cupola has a shell diameter of 108 inches and is of the Paxson-Colliau type, manufactured by the J. W. Paxson Co., Philadelphia. The diameter inside the lining is 84 inches, which is 3 to 6 feet greater than the lining diameter of the average cupola. There is only one other cupola of the same size and type in use. This was installed some time ago by the J. W. Paxson Co. at the League Island navy yard, Philadelphia.

Blast is furnished by a positive-pressure blower of the Wilbraham-Green type, supplied by the J. W. Paxson Co. This blower has capacity for supplying 14,000 feet per minute driven by a 75-horsepower motor. For receiving the molten metal, the cupola is provided with seven ladles which range from 7 to 35 tons in capacity.

An unusual mold is required for casting the turbine runner. Aside from the bottom plate and the cover plate, the mold is entirely of cores. These are 16 in number and their sides correspond to the 16 vanes in the casting. The cores are rammed of Milville gravel, properly reinforced, and are faced with sand. After drying, they are assembled on a circular bottom plate. The cores cannot vary 1/16-inch from the correct dimensions and they must be set

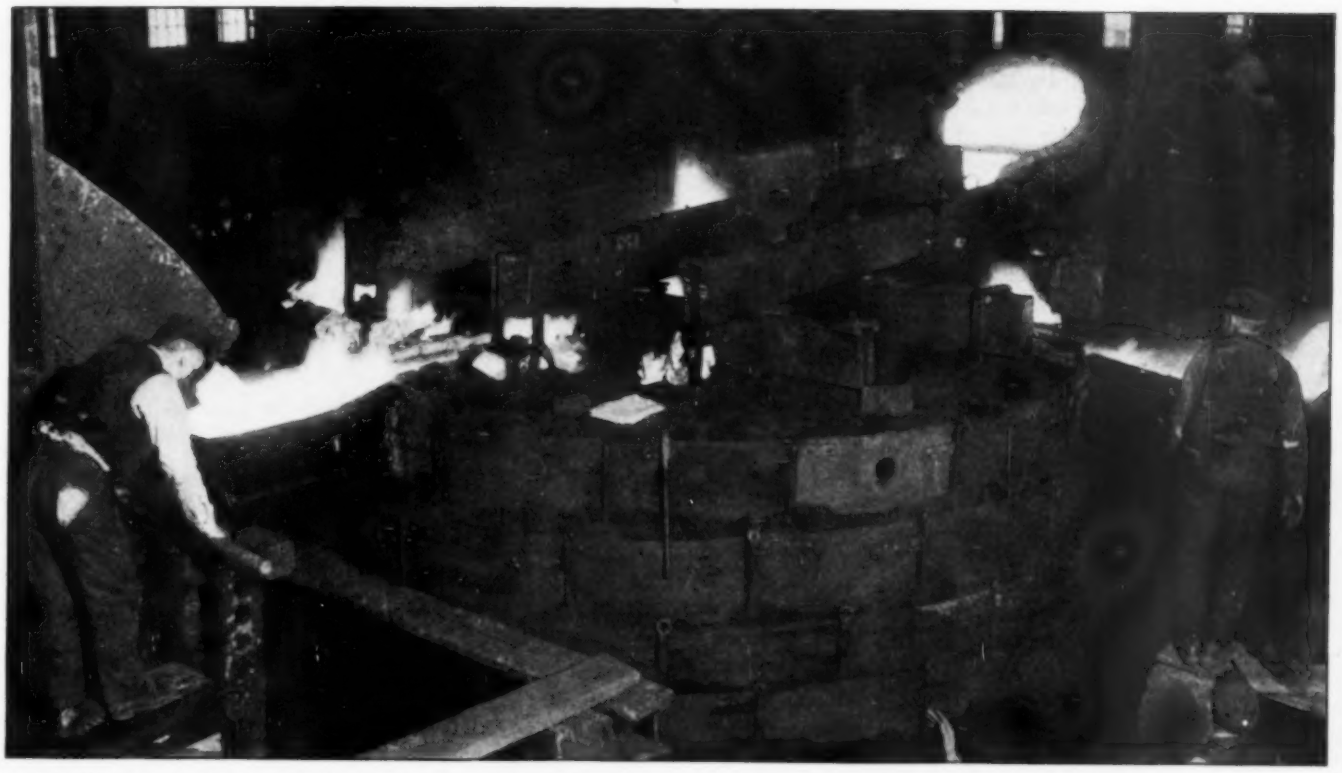


FIG. 2—THE MOLD WAS POURED FROM THREE LADLES SIMULTANEOUSLY CONTAINING APPROXIMATELY 116,000 POUNDS OF IRON. THE CASTING WAS ALLOWED TO COOL IN THE MOLD FOR TEN DAYS

with absolute precision. Each core is set to overlap the next and, after they have been assembled, sheets are placed about the mold a wall of sand rammed between the sheets and the cores.

The mold is poured simultaneously from three ladles which are placed with the aid of three 50-ton traveling cranes. The metal is poured into three basins whence it is distributed to all parts of the mold through ten 3-inch gates. To provide uniform contraction of the iron 10 days are allowed for cooling before the mold is opened. Thickness of the metal in different parts of the casting varies from ¾-inch to 5⅛ inches. Total weight of the mold, with the casting, is 135 tons.

Construction of the 93,000-pound turbine runner mold required 28 days. Two molders and two coremakers did the principal work, while the sand wall was rammed by a gang of 12 laborers.

Large castings, especially in connection with shipbuilding, are a specialty at the I. P. Morris foundries. For instance, a large casting just produced is a 50,000-pound bed plate for a ship engine. For drying the huge molds and cores for such castings, unusually large ovens are a part of the equipment. One of these is 16 x 36 feet and 20 feet high. Another is 16 x 36 feet and 15 feet high. Another is 28 x 36 feet and 16 feet high and two more are 12 x 36 feet and 15 feet high. All are of the car type and all are fired with bituminous coal.

"We formerly used anthracite coal,"

FIG. 3—THE 50-TON RUNNER AS IT APPEARED ON THE CLEANING FLOOR

said Mr. Matlack, "but during the war had to turn to bituminous and this fuel is entirely satisfactory. In our non-ferrous foundry we have oil-fired ovens. The other night at 2 o'clock one of the men called me up on the telephone and said a valve would not work. Nothing like this can happen in the operation of our bituminous coal fired ovens."

An unusual instance of heredity in the foundry business is found in the careers of Mr. Matlack and his father. David J. Matlack became connected with the I. P. Morris Co. as foundry superintendent in 1845 and later became a partner in the company. George C. Matlack, his son, was born in 1865, and entered the plant in 1880 and served an apprenticeship of four years in the various departments. When his father died in 1904, Mr. Matlack succeeded him and ever since has managed the I. P. Morris foundries. Exclusive of his foundry activities Mr. Matlack's chief interest is in traveling, and he has visited at one time or another practically all parts of the world during the past 20 years.

To Melt Steel in a New Induction Furnace

BY H. A. WINNE

ALTHOUGH the induction furnace has been used in the production of high grade steel in Europe for some years past, it has, up to the present, met with little success in this country, due principally to the difficulty of obtaining a satisfactory lining material. However, the General Electric Co. has developed a lining material which has helped to solve the refractory problem, at least insofar as basic operation is concerned. An induction furnace of 4000 pounds hearth capacity has been in succesful operation at the Pittsfield works of the company for more than a year.

The induction furnace is essentially a transformer, consisting of the usual laminated iron core, a primary, and secondary coils. However it differs from the ordinary power transformer in that the secondary coil is simply a single turn, or ring, of the metal to be heated, all the energy transferred to this coil being converted into heat.

This particular 4000-pound furnace is of the single-phase, single-ring, (horizontal) type. The laminated core, of transformer steel, is three legged and has an easily removable top yoke. The annular steel casing of the hearth surrounds the middle leg of the core. The hearth itself is circular, with a vertical section that is approximately V-shaped.

This lining consists of two essential parts, an outer layer of insulating and refractory brick, and the inner rammed lining, or hearth proper. The new refractory for the rammed lining is highly basic and forms a hard, dense lining which contracts or expands very little with temperature changes, and does not soften at the furnace operating temperature. It is without doubt to the development of this refractory, more than to any other factor, that the success realized in the operation of this furnace is due.

Brick in Lining

Next to the steel shell is placed a layer of heat insulating brick, and inside this are layers of firebrick. The refractory, with a tar, or pitch binder is rammed in place between the firebrick and a cast iron crucible form. The roof consists of special fireclay shapes, supported in two steel rings.

The furnace is provided with three charging doors in addition to the pouring spout. One door, located at the rear is also used for removing slag. The other doors are located 120 degrees from it. The pouring spout is of the tea-kettle type, so arranged that metal is poured from the bottom of the bath, thus insuring a slag-free metal in the ladle.

The primary winding is in the form of disk coils, insulated with mica and asbestos. It is enclosed in a brass casing suspended from the top yoke of the iron core, just above the furnace roof. The upper yoke and coil readily may be disconnected and lifted from the furnace as a unit. It is apparent that this construction places the winding entirely out of danger in case the molten metal should break through the crucible.

Since the primary coil and the bath carry currents flowing in opposite directions, it is concluded they repel one another, and the current carrying portion of the secondary which is the metal of the bath, is forced toward the bottom of the crucible, tending to drive the slag particles to the surface, thus cleansing the metal. The *pinch effect*, or the magnetic force which tends to cause the current carrying particles of the bath to be drawn together, also is thought to assist in

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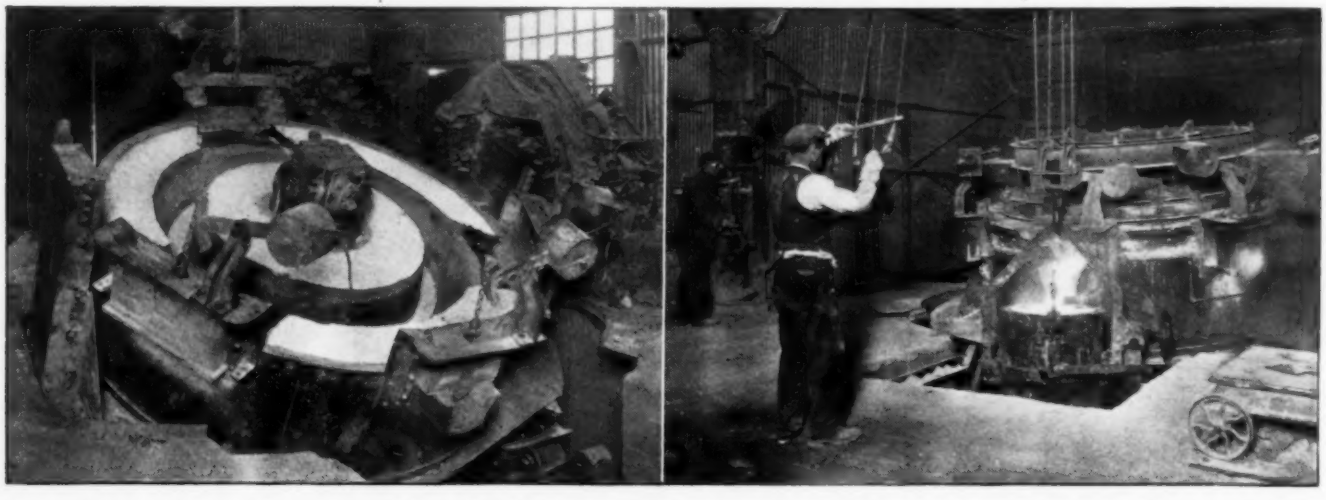

FIG. 1—INDUCTION FURNACE SHOWING RAMMED LINING IN PLACE FIG. 2—METAL IS POURED FROM A TEA-POT SPOUT BUILT IN THE FURNACE

this squeezing out of the dirt and slag.

The combined effect of these two magnetic forces also gives rise to a gentle circulation of the metal which assists in establishing uniform composition and temperature throughout the whole bath.

The primary coil is cooled by air which is forced through a cylindrical casing surrounding the middle leg of the core, into the metallic casing around the core itself. This air is supplied by a small motor-driven blower. No water cooling is used on any part of the furnace. The furnace is mounted on a motor-operated rocker-tilting mechanism, which allows it to be tilted forward for pouring, or backward for removing slag.

Since the induction furnace is in reality a transformer, it can operate only on alternating current. As there is of necessity a considerable space between the primary coil and the metal bath, or secondary, the leakage reactance is high, which in turn results in a low power factor. In order to obtain a reasonable power factor, the frequency of the supply circuit must be lower than the usual commercial frequencies. The 4000 pound furnace is designed to operate on a 15-cycle, single-phase circuit at a maximum voltage of 2200. The maximum power input is 250 kilowatts.

The single-phase, low-frequency power is obtained from a 15-cycle 500 kilovolt amperes, 50 per cent power-factor, driven by a 60-cycle synchronous motor, which can be operated at unity, or at a leading power factor. The generator oil circuit breaker and field rheostat are controlled by push buttons located on a small board near the furnace, so that the rate of power input is always under the immediate control of the furnace operator.

As previously stated, the furnace has now been in continuous successful operation for more than a year, more than 2300 tons of metal having been melted. It has been used almost exclusively in the reclamation of sheet steel scrap.

Must Have Continuous Circuit

After relining, the furnace is started by melting down a solid steel starting ring, weighing about 1700 pounds. It is necessary to use either a solid ring, or molten metal; if the channel is simply filled with loose scrap, the resistance of the charge, due to the multiplicity of poor contacts, is so high that the induced voltages cannot force through sufficient current to melt the metal. For the same reason, when the furnace is being used to melt cold scrap it is never completely emptied between heats; usually about half the total bath is poured. The remainder is left in the furnace, and the new charge is added to it. Of course, if the furnace is employed for refining molten metal, that is, if molten charges are available, the entire bath may be poured.

When the starting ring has melted, the bath is covered with a slag of lime and fluor spar, and the sheet steel scrap in the form of bundles is added as fast as it can be melted, until the bath totals about 4000 pounds. By the use of ore and alloys the bath is brought to the desired composition, and 2000 pounds of metal is poured. Scrap is again added, and the process repeated, 2000 pounds of metal being poured every 3 or 3½ hours. The furnace is operated continuously 24 hours a day, 7 days a week, throughout the life of a lining. It is operated by a crew of three men on each shift. This crew takes care of all operations in the furnace building, as well as the motor-generator set, blowers, and crane. None of the men had had any experience in steelmaking previous to their work on this furnace.

The power consumption over a run 604 heats averaged 687 kilowatt hours input to the furnace per ton of metal, and 957 kilowatt hours per ton including losses in the motor-generator set, and power for crane, lights and blower. During one day when no delays, such as waiting for scrap were encountered, the average power consumption was 607 kilowatt hours at the furnace, and 866 overall.

Perhaps the most remarkable feature of the work at Pittsfield is the length of the life of linings. Of 12 consecutive linings the average life has been 185 heats each. This includes four experimental linings which averaged only 73 heats each. The operating practice has been gradually developed until on the run just completed, 604 consecutive heats were made on one lining, the length of the run being 93 days. The lining previous to this ran 86 days, giving 555 heats. These records, so far in advance of anything previously done with the induction furnace in this country, were made possible by the development of the new refractory used in the lining, and by improvements in the construction of the furnace, principally that of placing the coil above the bath, and providing doors so that the whole lining may be inspected and patched when necessary.

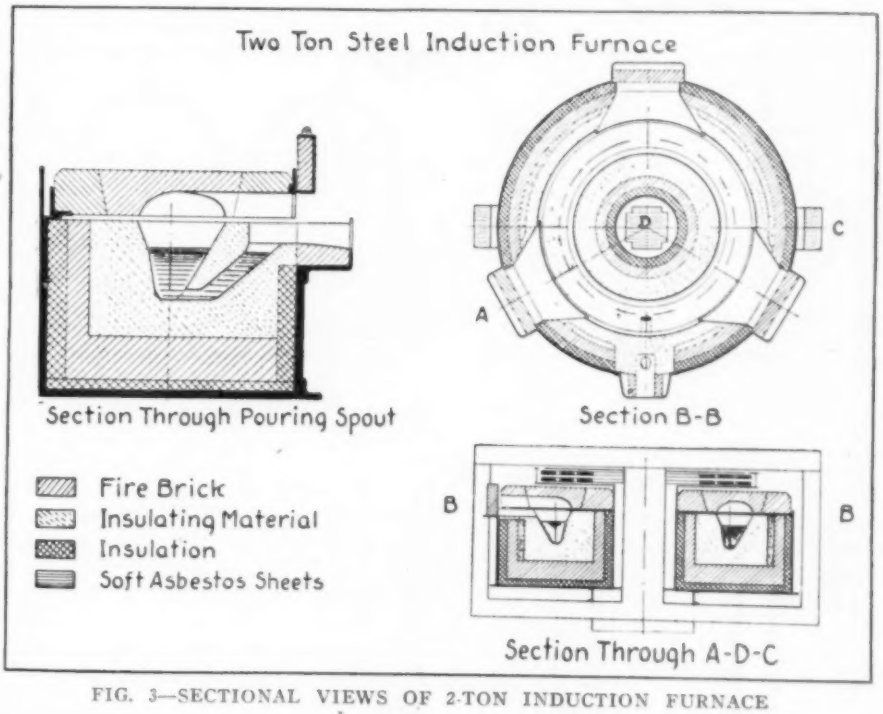

FIG. 3—SECTIONAL VIEWS OF 2-TON INDUCTION FURNACE

Lining failures usually occur in the outside crucible wall, the shell of the furnace becoming hot at the points of failure. It is seldom that a failure does any damage to any part of the furnace or lining other than the rammed hearth. The coil is out of all danger, being located above the roof, and the core is protected by refractory material. The lining is readily patched when required by simply throwing lining material against the wall, where it fuses in place.

When a lining fails the furnace is emptied, the top yoke, coil, and roof removed, and the hearth filled with water, cooling it quickly. The rammed lining is then torn out, and a new

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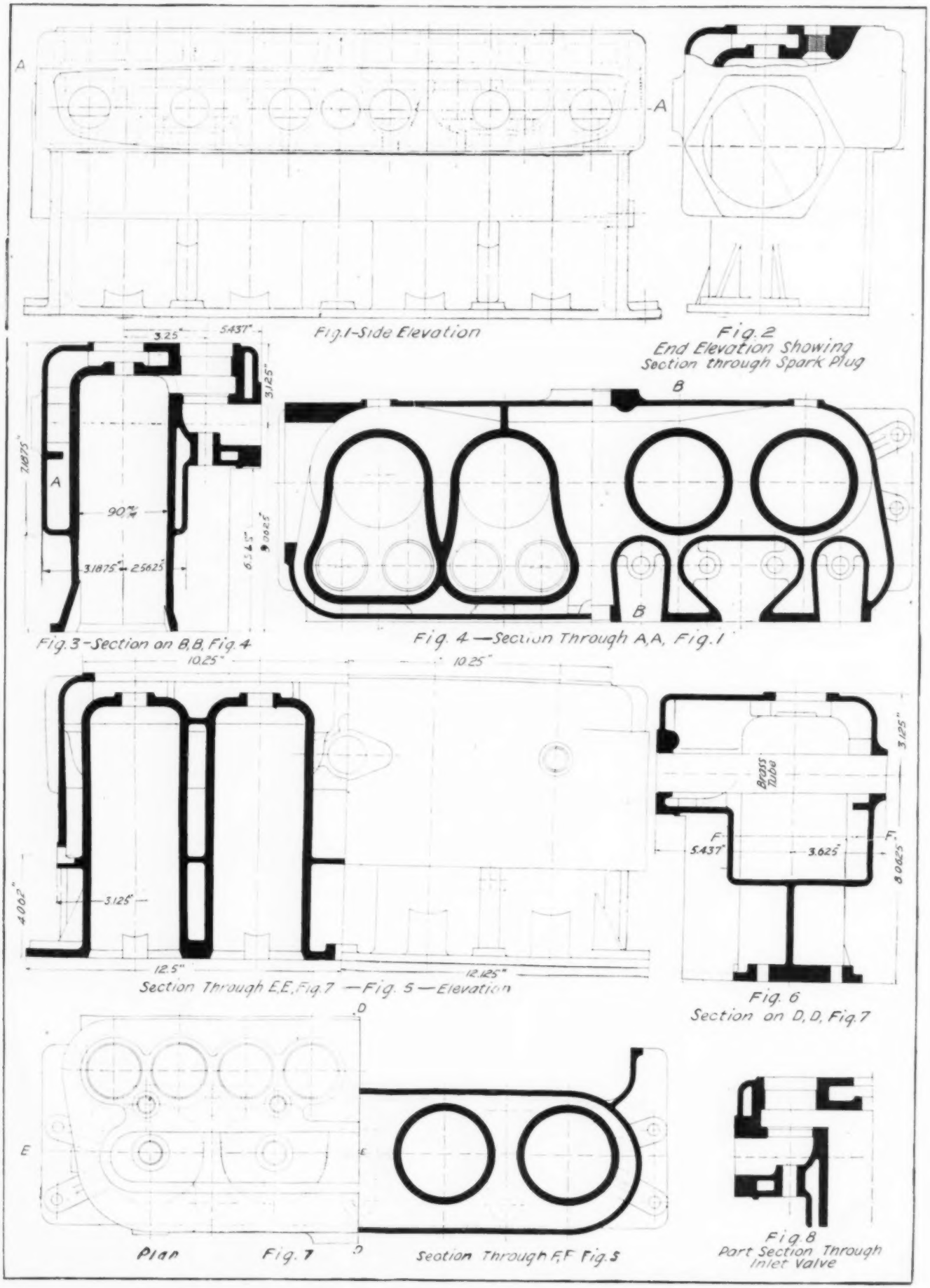


FIGS. 1 TO 8—VIEWS OF THE PATTERN FOR THE WATER-JACKETED CYLINDERS

British Motor Castings Methods--I

Details Given of Making a Wooden Pattern of a Water-Jacketed Cylinder Block for an Internal Combustion Engine of a Design Typical of This Class of Castings

BY BEN SHAW AND JAMES EDGAR

WITH the development of the gas engine innumerable types have been introduced differing considerably in details, but worked on the same principle. For instance there is the gas engine proper as apart from the oil engine, and the latter may be divided broadly into two categories, those designed for gasoline and those for the heavier oils such as engines of the diesel and semi-diesel types.

This series of articles is confined to the types of engines used for motor vehicle work. In considering gasoline motors it is difficult to decide on an engine which combines all the difficulties and intricacies of design which have to be coped with by foundry craftsmen. The cylinder, crankcase, etc., dealt with in these articles are of a representative type of engine and the methods adopted in making the various parts should be applicable to almost any other automobile engine. It is an engine made by the Vulcan Motor Engineering Co., Lancashire, England. The cylinder is water jacketed. A discussion as to the relative merits of water and air cooling would be out of place but it may be assumed that there is at least as much difficulty in casting a water-jacketed cylinder as in casting one with vanes for air cooling.

Exceptional accuracy in workmanship is necessary to get good results in this class of work. The patternmaker should not be satisfied with *nearly* correct. The metal is too thin to allow of any liberties being taken with it. When a casting is 1½-inch or 1-inch thick a 1/16-inch error may not spoil it, but it is different when the thickness of the metal is ¼-inch and sometimes only ⅛-inch. Extra labor in the pattern shop will be repaid later in the machine and assembling shops.

Leave Nothing to the Molder

The opinion commonly expressed in pattern shops that nothing should be left to the molder is liable to be carried too far in general work but not in motor work. It is obviously ridiculous to cut solid fillets or even glue leather fillets round a big bedplate as such large fillets easily can be made by the molder sufficiently accurate and in little time. But a ⅛-inch or ¼-inch fillet in motor work may be defining a thickness of metal and should be done in the pattern shop. Apart even from the metal thickness weight is an important factor and is kept down to the lowest limit.

Recommends Leather Fillets

An important reason why it is profitable to pay attention to the minutest detail in motor work is that except for an occasional experimental job large quantities are usually required off the same pattern. For a purely experimental job it is waste to make a more elaborate pattern than is actually necessary to get a trial casting, but once a design has been determined and hundreds or more probably thousands of castings are required off of each pattern no effort should be spared to make the pattern so perfect as to reduce the molders' labor to a minimum.

It will be profitable to consider the materials used in patternmaking for motor work. Although for small work and air-cooled work aluminum patterns are usually employed, for a wood pattern mahogany or baywood is best. For working up and even for withstanding varying atmospheric conditions yellow pine is excellent. The best quality of yellow pine, dry, straight-grained and free from knots is convenient to work and finishes well. However, it is easily dented and if molders are careless the wood may be split. Teak is sometimes used but it does not take a good finish, and has other qualities which render it unpopular for patternmaking. Straight-grained mahogany and baywood are easily worked and stand foundry conditions well. Other woods are tried for patternmaking from time to time but have not been generally adopted.

The question of filleting and dowelling also is important for this class of work. Wood fillets are not suitable only for rough work. Wax fillets formerly were popular in motor pattern shops but as a general rule they are not as good as leather fillets. If wax fillets are used small dumb-bell shaped rubbers should be employed of the correct diameter to rub them into shape, the rubber being continually dipped into boiling water. Wax fillets are dirty to work with because it is difficult to keep the wax off other parts of the pattern but another objection to them is that if the pattern is placed near a stove they are apt to run. The leather fillets have become popular because they are easily fixed, they make a neat fillet, and they are permanent. Moreover with some practice the skilled man can form a leather fillet round the most awkward shapes using the rubber as for wax fillets. No loose fillet is comparable, however, with that carved from the solid lumber, but it is altogether too costly to carve fillets round all bosses and ribs. However, for loose pieces, the fillets should always be cut from the lumber.

Metal dowels are nearly always superior to wood dowels and, for motor work, are invariably used. Wood dowels usually tempt the molder to use his knife and thus spoil the dowel, and it is difficult to get a nice easy fit even in hard wood that can be relied upon to remain so.

As with other classes of patternmaking and molding, practice varies in different shops, but the aim of all patternmaking is to reduce the molding costs. A great proportion of motor work can be done conveniently on molding machines and some firms contrive to do even cylinders on machines. However, it is questionable if making a water-jacketed cylinder on a machine is highly advantageous because most of the work is in making the cores, and the handwork here cannot be eliminated.

Reduce Molding Costs

Plate molding as distinct from machine molding is frequently resorted to. There is also the question of whether a job should be molded on end or parted longitudinally. Endwise molding, experienced molders are agreed, gives better results and sounder metal, because a suitable head easily can be put on the casting. But endwise molding has for some unaccountable reason never been popular in this class of work. It may be admitted of course that much jacket coring is more troublesome when a job is molded on end.

It is not out of place to consider here machining and contraction allow-

ances. It is not customary to vary the contraction allowance for length, width and height. The contraction is fairly uniform and there is not usually enough variation in metal thickness to cause unequal cooling to a marked degree. As a general rule it is safe to allow 1/10-inch per foot for contraction, but it depends to some extent on the metal mixture. Machining allowances vary in different shops, but it is not usual to leave more than ⅛-inch for finish, and this is sufficient if the patternmaking is first class, and the pattern is properly molded. On some parts 5/32-inch must be left but on others 3/32-inch is sufficient.

Figs. 1 to 8 show details of the cylinder, the construction of which is discussed in this article. We shall not consider the endwise method of construction but proceed on the conventional lines for this class of work.

A good understanding of the design should be obtained before considering the patternmaking. In this class of work no real constructional difficulties are encountered by the experienced man, such as are met with on big work. Patterns are invariably made from solid lumber. Fig. 9 is a section of the completed body of the pattern. The pattern joints are made on the line *A B* and *CD*. As far as making the pattern or its easy delivery from the sand is concerned a joint at *CD* is not essential, but the molder has no option but to make a joint through the valves in order to set the cores, hence the patternmaker must define the joints.

Parallel Tongue

That part of the pattern which is up in the mold does not present much difficulty. The parts of the cylinder which are beyond the jacket can be turned easily and although the prints are not shown in Fig. 9 they are better turned as part of the bodies. Those cylindrical parts are best tongued into the jacket portion with either turned tongues or parallel tongues, as shown in Fig. 10. The parallel tongue is perhaps the better but it takes more care to fit. It is not proposed to suggest the best tools to use for performing the various operations described in these articles, a knowledge of the elements of patternmaking and molding being presupposed, but it may be said that if parallel tongues are carefully gaged, planed and then tested with calipers, and a router is used to recess the main body, a satisfactory result is assured. Slovenly workmen may be satisfied with a joint made level with sandpaper or showing packing, but it is not creditable work.

The pieces *E* and *F*, Fig. 9, can be shaped separately and glued on A section of the line *GH*, Fig. 9, is shown at Fig. 11. It may be noted that the center of the jacket is on a different plane from the cylinder center and a decision has to be made as to whether it is better to drop the joint. It is much better in molding and for core setting if the joint is on one plane, and the difficulty can be overcome by dovetailing loose pieces at the ends of the body so that they can be drawn into the mold after the pattern has been delivered from the sand.

Avoids Sharp Edges

Fig. 12 is a section on *KL*, Fig. 9, and shows both joints. The bottom piece A delivers freely but the middle piece B locks at the ends and pieces have to be dovetailed on as explained for Fig. 10. These dovetails should be made separately from the pattern pieces and may be about 5/16 to ⅜-inch thick with a quick taper in the length so that they will free easily. The facing, *M*, Fig. 9, and other portions that cannot conveniently be dovetailed either should be wired or screwed. But even where a piece is not on the joint the dovetailing method is good. The dovetail can be made sufficiently long and planed flush with the surface after which a round facing can be fastened to any part of it.

In assembling the pattern it would not be satisfactory to rely on screws holding the part *B*, Fig. 12, to the other jacket portion shown at Fig. 11. For good class work such as this a butt joint, even if glued and screwed, is not reliable. The best way would probably be to tongue the two parts together. They may be glued first and quite a good result would be obtained by carrying the tongues on the cylindrical ends all the way across the pattern. Some craftsmen would carve the fillets at the junctions of the various parts of the body from solid lumber, but this is needlessly costly, and leather fillets should be used here. Whether the facings on the top of the cylinder are better made separately and screwed on or carved in wood is debateable. In the writer's opinion a separate facing with a square edge against which a ¼-inch fillet can afterwards be glued is best. Here it may be mentioned that for the benefit of those who have never used leather fillet sprigs should never be used to fix it. It is surprising how often they are used and they spoil the fillet. Thin glue is all that is ever needed.

It is not necessary to discuss such minor details, important as they are, as the making and fastening of small bosses and ribs. However, it may be said that dovetails are always better than dowels, screws, or nails. It may be difficult in all cases to get a fillet, but if necessary, and in order to obviate sharp or feather edges, recesses should be cut to receive ribs when they must be drawn separately from the main body of the pattern. If a recess ¼-inch deep is cut to receive a facing or rib, this assists in locating it in rescrewing the pattern, in addition to making a strong edge. Sometimes of course sharp edges only are avoidable by considerable labor, and consequently are sometimes left on certain parts. This would apply to the facings and ribs on the main flanges of the cylinders. The ribs that are showing plainly in Figs. 1, 5, and 6 between the cylinder should be let in to the pattern joint. If they have a *landing* of about ½-inch they can be securely screwed from the joint.

The main flanges do not need much explanation. If the cylinder prints are turned as parts of the cylinders then the planed and finished flanges may be fitted over them, and screwed from the joint. However, it is advisable to taper them slightly both at back and front. In motor patterns, as in all other patterns, taper should be left on all parts that will be lifted vertically from the mold.

The most awkward parts of the pattern are the brackets or feet which are shown clearly on several views but most clearly perhaps on Figs. 6 and 7. It might be possible to make these parts exact duplicates of the casting, and it would be good practice if the cylinder was big and of the reciprocating type, but it would be impracticable for a small job like this from which so many castings would be required. Drawbacks would have to be made by the molder at both ends of the cylinder and they would involve much more labor than making block cores which is by far the more satisfactory way. There is no danger of the feet being moved out of position when cores are used. There is also the possibility of the thin lumber warping if shell patterns are made. Satisfactory block prints are shown in Figs. 13 and 14. They should be carried up to the pattern joint. These prints need not interfere in any way with the construction of the pattern as they are fitted between the flange and the valve chest and being comparatively small they may be made from solid lumber.

Prints Not Deep

Printing a pattern such as this is important. The prints *A* in Fig. 14, which shows the finished pattern, need not be deep, as they are guide prints only. Some patternmakers would shape these prints from the correct size at the bottom to ¼ or ⅜-inch smaller at the top, and make the corebox to suit, but it is open to ques-

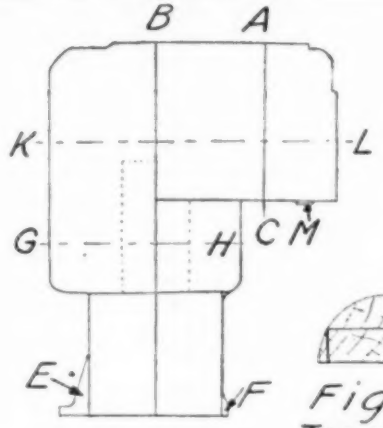


Fig. 9
Section of the Completed Body of the Pattern

Fig. 10
Tongues

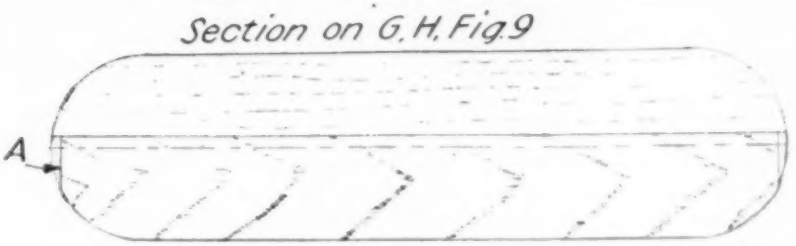


Fig. 11

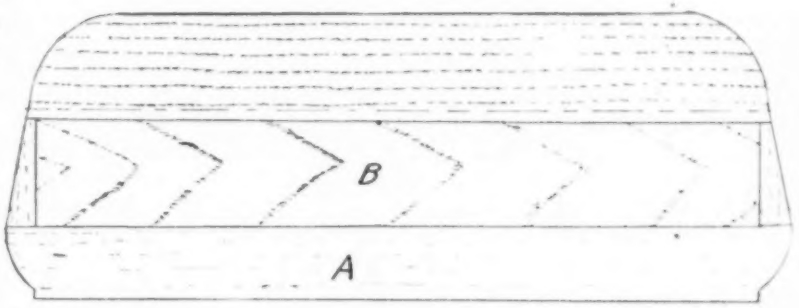


Fig. 12
Section on K L Fig. 9

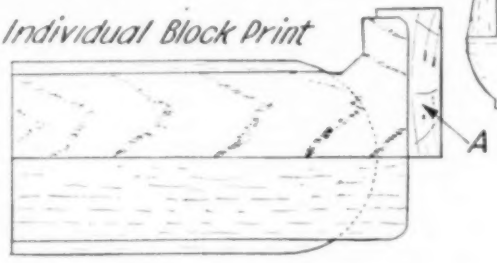


Fig. 13

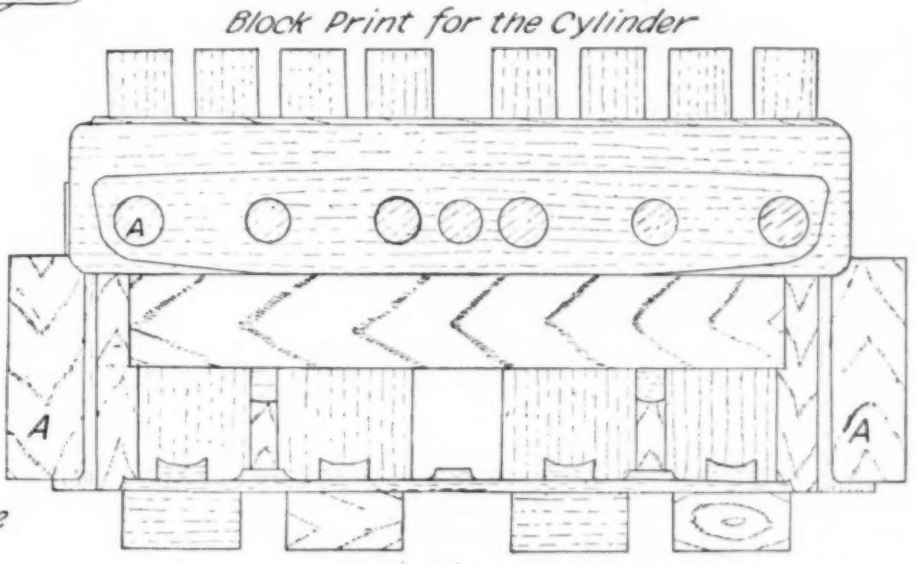


Fig. 14

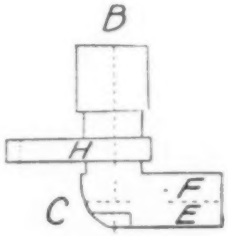


Fig. 15
A
Section of the Valve Core

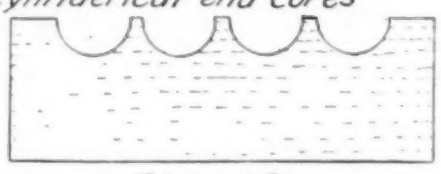


Fig. 16

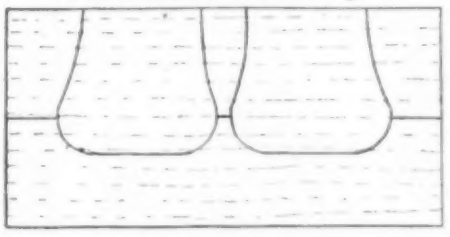


Fig. 17

FIG. 9—SECTION OF THE COMPLETED BODY OF THE PATTERN. FIG. 10—TONGUES. FIG. 11—SECTION ON GH, FIG. 9. FIG. 12—SECTION ON KL, FIG. 9. FIG. 13—INDIVIDUAL BLOCK PRINT. FIG. 14—BLOCK PRINT FOR THE CYLINDER. FIG. 15—SECTION OF THE VALVE CORE. FIG. 16—TOP AND BOTTOM HALVES OF THE CYLINDRICAL END CORES. FIG 17—COREBOX FOR PART H, FIG. 15

tion whether this is an advantage in this case. The main prints on the top and the bottom of the cylinder should be about 2 inches long, and the faces should have a considerable taper on either side of the joint. Looking at Figs. 1, 2 and 4 it may be observed that there is a large branch with a hexagonal flange on one end of the cylinder. This will not give either the patternmaker or the molder much concern, but a fairly large print should be left.

Corners Taken Off Last

When all the facings have been screwed on the finishing touches may be given the pattern. Until this stage is reached no corners should be taken off. It is difficult even for highly skilled men to so visualize the finished pattern that they can safely take off rounds before all the parts are assembled. To ensure accuracy in metal thickness templates should be used for all rounds above ¼ inch. In addition to finishing off rounds, and indeed before these are done, all fillets should be glued on, and the whole pattern then sandpapered. It is usually necessary to test all loose pieces after the pattern has been varnished and especially is this so in dovetails.

The construction of the various coreboxes is generally considered much more difficult than making the pattern of a motor cylinder. The cores of the cylinder we are considering are not specially difficult but nothing can be left to chance. Every detail of the core must be thoroughly understood by the foreman, or whoever is in charge of the job. This is the only way to make certain that one core will fit properly into or against another and that there will be no lumps of metal cast in corners. The danger of leaving thick metal is almost as great as that of leaving it thin.

The cylinder corebox itself is the simplest to make. It may be said that there is no question of striking any of the cores. The cylinder barrel corebox must, of course, be made in halves dowelled together. Here it may be said that because of expense the coreboxes are frequently made of soft wood even when the pattern is made of mahogany. However, the author does not agree with this idea. If a pattern is well made it will not wear more than the coreboxes. In nearly all cases patterns and coreboxes should be made of similar wood.

Without examining all the cores it is obvious by looking at the working drawings that it would not be satisfactory to make a butt joint of the cylinder core and that part of the valve core which joins it. On first examining the cores one is inclined to make that part of the valve core on the cylinder side of the center line and the cylinder core, in one box, but a difficulty at once presents itself. It would not be possible when coring up to set the cores, because of the jacket core which is between the cylinder and the valve. The only practical way is to carry a print up to the center line of the cylinder. The cylinder cores change near the flange and templates should be used to make sure that the shape follows the pattern.

The foot or bracket corebox is comparatively simple. It is a framed box with a bottom on which pieces representing the cylinder and the inside of the rib are screwed. While it is a fairly deep box it should not be necessary for the coremaker to unscrew if a slight taper is given to the sides. If it is screwed and not glued the coremaker will be able to loosen it if he finds it necessary.

The valve corebox and the jacket boxes are decidedly awkward. It will help us to understand the valve box better if we view a section of the core quite away from the main drawing, Fig. 15. It would be necessary to joint the box on the lines *AB* and *CD*. The part *E* would be dowelled separately to the part *F*. It would not be advisable to carve the three parts of this corebox, from single pieces of wood. Fig. 16 shows the cylindrical end cores, the top and bottom halves being exactly the same. Fig. 17 represents the part *H*, Fig. 15 . From the coremakers' point of view this is the most awkward part of the box. This core may be either cut through the bottom of the box or a thickness left which will form a bottom. The other parts of the box are not difficult but they take some time to carve and templates should be used.

Jacket Coreboxes

We shall now discuss the troublesome boxes—those for the jacket core. Fig. 3 indicates that while the whole core could be made in one corebox it would be impossible for the molder to set it. As a matter of fact three coreboxes must be made. The top of the first box must be the center line of the valve and the other two parts must join on the cylinder center line. In coring-up, the first jacket core is set, after which the valve core can be placed in position. The next to be placed is the middle portion of the jacket core, then the cylinder core and finally the top jacket core. We are supposing now that the valve will be molded in the drag, but even if the valve is molded uppermost in the cope, the same divisions of the cores must be made.

Figs. 22 and 23 represent one corebox for the part marked A in Fig. 3. Fig. 23 is a section looking toward A, Fig. 22. As may be seen the width of the box is made of three pieces for convenience in cutting the fillets. The dovetailed parts at each end are, of course, necessary because of the centers of the cylinder and the jacket being on different planes. The cylinder bodies are not always made as shown. These are turned and the fillet thickness is made with the grain at right angles to the cylinder. A better job, but more costly, is obtained by cutting circular recesses in the side of the box thus obviating sharp-edged fillets on the cylinders. The dovetails locate the cylinder easily and are useful although a batten must be screwed on the top and dowelled on to the ends of the box. After the core is rammed, the batten is lifted with the half cylinders, and the dovetails immediately locate it for the next core. Objection may be made to the dovetails on the ground that they may jam when lifting, but if they are well made there is no danger of this.

Delicate Cores

The middle part of the jacket core takes more watching than the box we have just considered. The two sections, Figs. 20 and 21 show it much more clearly than an outside view would do. The depth of the box is the distance between the centers of the cylinders and the centers of the valves and it has to be made longer than the core length because the ends lock and thus loose pieces must be made and dovetailed to the ends of the box as shown at *A*, *A*, *A*, *A*, Figs. 20 and 21. Fig. 20 is a view through the core that breaks into the cylinder while Fig. 21 is through the center of the valve, the top of the box in each case being the center of the cylinder. From the coremaker's point of view this is the most delicate core of the cylinder and the patternwork inside the box should be first class in order to assist him. There is not much room for leather fillets here and the fewer the number of parts inside the box the more certain is it that centers will be accurate. There is thus a great deal of carving in the box. It is not necessary to show a joint view of this box as it is identical with Fig. 18 which is a joint view of the top jacket corebox. The various pieces representing the valve body should be screwed well to the bottom of the box, as they will not require to be loosened off in making

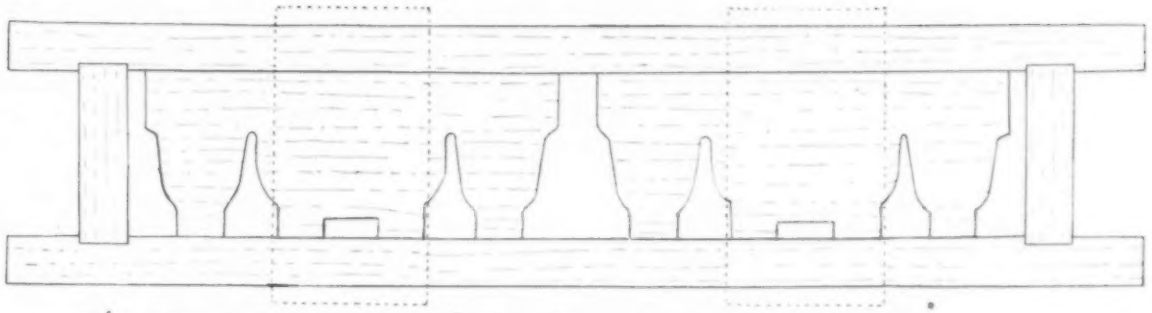


Fig. 18-Joint View of the Top-Jacket Corebox

Fig. 19 End View of the Valve Chest

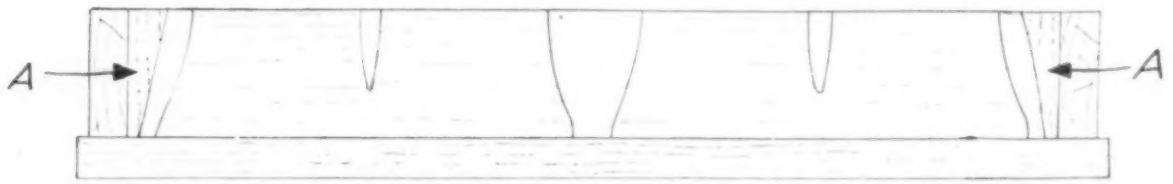


Fig. 20-Section of the Corebox for the middle part of the Jacket Core, where the Core breaks into the Cylinder

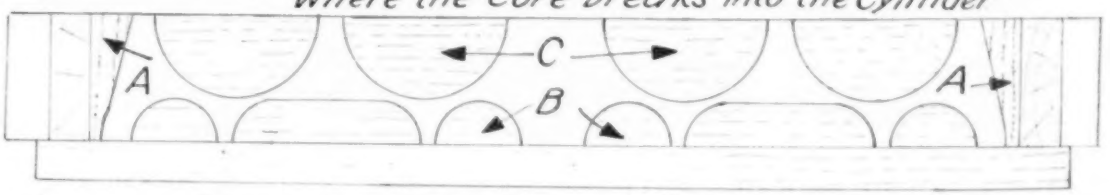


Fig. 21-Box for same core as Fig. 20-View through Center of the Valves

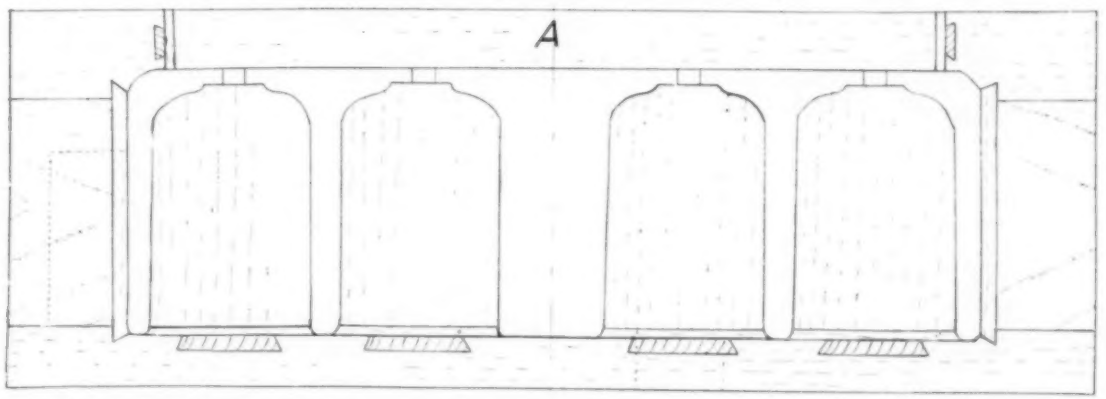


Fig. 22-One of the Coreboxes for the Water Jacket

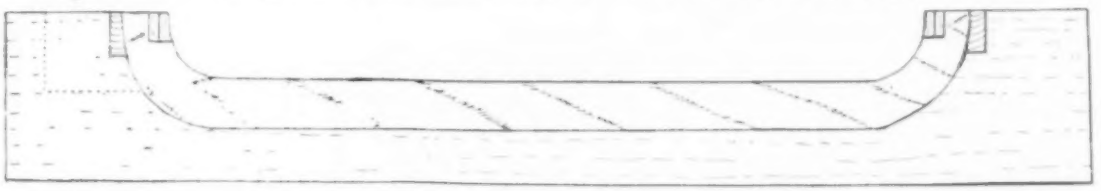


Fig. 23-Section Looking Toward A. Fig. 22

FIG. 18—JOINT VIEW OF THE TOP-JACKET COREBOX. FIG. 19—END VIEW OF THE VALVE CHEST. FIG. 20—SECTION OF THE COREBOX FOR THE MIDDLE PART OF THE JACKET CORE WHERE THE CORE BREAKS INTO THE CYLINDER. FIG. 21—BOX FOR SAME CORE AS FIG. 20—VIEW THROUGH CENTER OF THE VALVES. FIG. 22—ONE OF THE CORE BOXES FOR THE WATER JACKET. FIG. 23—SECTION LOOKING TOWARD A, FIG. 22

the core. The cylinder body pieces C, C, C, C, Fig. 2, must be fastened to a dowelled batten as already described for the other jacket box.

We may now briefly describe the last jacket box. The joint view Fig. 18 will be better understood by reference to Figs. 3 and 4. Fig. 4 shows us that while openings are diameters at the face of the valve they immediately begin to spread, and this makes it impossible to screw any blocks on the bottom of the corebox. It could be done by dovetailing the portions that are against the draw, but it would be a clumsy job and there is no other alternative but to fasten the entire internal blocks to cross battens as indicated in Fig. 18 by the dotted lines, and draw them from the top before the core is turned out of the box. The advantage of the battens being crosswise instead of lengthwise in the box is that room is left for ramming up the cores. Fig. 19 is an end view of the valve chest showing that the branches are not separate as appears in Fig. 3.

There are various small cores on the cylinder which it is not necessary to consider.

Sometimes an endeavor is made to prepare all subsidiary coreboxes as separate boxes, but considerable discretion must be used in doing so as some of the cores have little support and few means of determining their relative positions in the mold. The practice of making a dummy set of cores and having them assembled so that slight alterations may be made before the work is actually put in the hands of the foundry is to be commended in complicated work of this character.

The ribs which are shown in the various views connecting the inner and outer walls of metal involve considerable labor. It is not satisfactory to simply screw them to the bottom or sides and relocate them for each core. When they are on the joint they should be checked into the sides or the internal blocks and made of lumber sufficiently thick to allow of a template being cut where they join the metal, and the practice of letting in as it is called in some patternshops should be followed where it is possible to do so.

Conditions Governing Cast Iron Welds

THE feasibility of welding cast iron sections of widely divergent sizes and shapes, is a question that arises nearly every day in various industries. The following explanation recently was prepared by the Metal & Thermit Corp, New York, regarding the condition governing cast iron welding, by use of its material.

Steel is the welding material employed and consequently the metal at the repaired point will consist of a mixture of steel and cast iron. The graphitic carbon in the cast iron unites with the steel resulting in a high carbon steel which usually can be machined only by grinding. The material is not so brittle as cast iron and is stronger physically.

The superheated steel produced by the reaction of this type of welding fuses back into the fractured parts 2 or 3 inches on either side, and the whole mass solidifying at one time effects the repair. The excess metal may be removed afterward or not depending on circumstances. If it does not interfere with the part functioning, it may as well be left on.

In considering cast iron repairs by the process, it should be borne in mind that the weld material is steel with practically twice the shrinkage of cast iron. This factor is of no consequence where the section to be welded is approximately square or circular. However, where the length of the section at the fracture is four or five times the thickness, the difference in shrinkage will be shown by one or more minute cracks perpendicular to the line of the weld and extending through the weld material only. These cracks will be found in thin welded sections, but not in sections which have a large area. The cracks are not important, as they are parallel to the line of strain.

Where the length of a fracture is not more than four or five times the thickness and where the subsequent machining can be done by grinding, it is claimed that a thermit weld can be made successfully. The accompanying illustration shows a weld of this character recently completed to the cast iron side frame for a power press at the plant of the Leonard Sheet Metal Works, Inc., Hoboken, N. J.

FINISHED WELD AS IT APPEARED BEFORE THE POURING GATE AND RISER WERE REMOVED

To Melt Steel in a New Induction Furnace

(*Concluded from Page 9*)

one put in. The brick do not have to be replaced, and approximately 50 per cent of the material of the rammed lining which is torn out is reclaimed for use in future linings. The total time for relining, from the time of the failure to the melting of the starting ring on the new hearth, is from 50 to 60 hours. The total number of man-hours labor required is about 120. The work is done by unskilled labor, under proper supervision. The life of the roof is long, the first one being used for more than 1600 heats without repairs.

Architects To Exhibit

The architectural league of New York is interested in forming a better understanding between foundrymen and architects as to what each can produce or use. With this in view the League has decided to hold periodic exhibitions in the rooms of the League at 125 West Fifty-seventh street, where materials will be displayed. These exhibits will be open not only to the members of the league but also to the general public. The dates will be announced as soon as they are decided upon.

Casting Heavy Iron Ingot Molds

Instead of Being Regarded as Special Jobs Necessitating Individual Rigging and Methods, These Castings Are Handled in a Routine Manner as Part of the Days Work

BY JOHN H. EASTHAM

DETAILS published recently in THE FOUNDRY describing the methods employed in making an ingot mold casting weighing 85 tons, by the Brightside Engineering Co., Sheffield, England, presented points of interest to foundrymen in general and to those in particular who are familiar with foundry operations in the Pittsburgh district. The casting referred to was of the occasional type and consequently made in loam. The mold and core were built up to a skeleton pattern. A description of the method employed when castings of the same nature are made on a production or quantity basis is of interest.

Figs. 2 and 4 are views in plan and cross section respectively of an ingot mold casting 13 feet long by 7 feet 3½ inches average outside diameter. The metal mold section showed an average thickness of 16 inches. The iron mold was designed to form octagon or 8-side steel ingots.

The ingot mold castings are made approximately 2 feet longer than required, the extension or shrink head thus formed eliminates churning and gives a uniform density from end to end of the casting. As it leaves the foundry for the machine shop, the casting weighs 50 tons.

Here it may be noted that the foundry under discussion is well equipped with standard interchangeable jobbing flasks of circular design, varying in diameter from 48 to 100 inches each section being 12 inches deep. The manufacture of these flasks will be considered on another occasion.

Pattern Bidded in Drag

Usually the crew employed on the job comprises one smart young journeyman molder, one apprentice and one helper. A circular drag flask 100 inches diameter is bolted to a suitable bottom plate laid level on the floor. It is rammed solidly full of floor sand and struck off level. An area a little larger than the pattern core print is dug out and swept out to correct depth by a second strike. The pattern afterward is lowered to place and a parting made flush with the lower edge of the pattern and the upper edge of the flask. The first cheek part, short barred or chucked at appropriate intervals, is now rammed being closely hook gaggered to avoid trouble later when removing the pattern. Gate sticks as shown at Fig. 3 are set to position diametrically opposite each other.

These sprue sticks as shown in the illustration appear to be full length, but actually are made about 4 feet long and are drawn up as the ramming progresses. This is done to facilitate their withdrawal from the complete mold, if they were made 12 feet long, their removal would be almost impossible.

When ramming the second cheek, or some 15 inches above the base of the casting, the first pair of inlet gates are bedded in. They are tapered to allow of their easy inward withdrawal.

At the upper face of the fourth cheek part, a second parting is made, the first pair of trunnion cores being set to their positions as shown while ramming the third cheek. Succeeding operations from this point are a repetition of those just described, a barred cheek, well gaggered, being used above each parting. The mold, 14 feet high, is divided into three sections.

The problem of filling the flasks with sand as the mold grows higher is overcome by the simple expedient of piling up, as close to the mold as possible, a set of empty flasks for the next casting to be made. The pile is covered with a bottom plate and used as a sand platform from which the floor sand is shoveled into each flask. A crane-operated, grab bucket dumps a load of sand on the plate as often as required. The facing sand for the lower courses is banked around the pattern by the riddle full, but later is dumped on the top face of the pattern by the grab

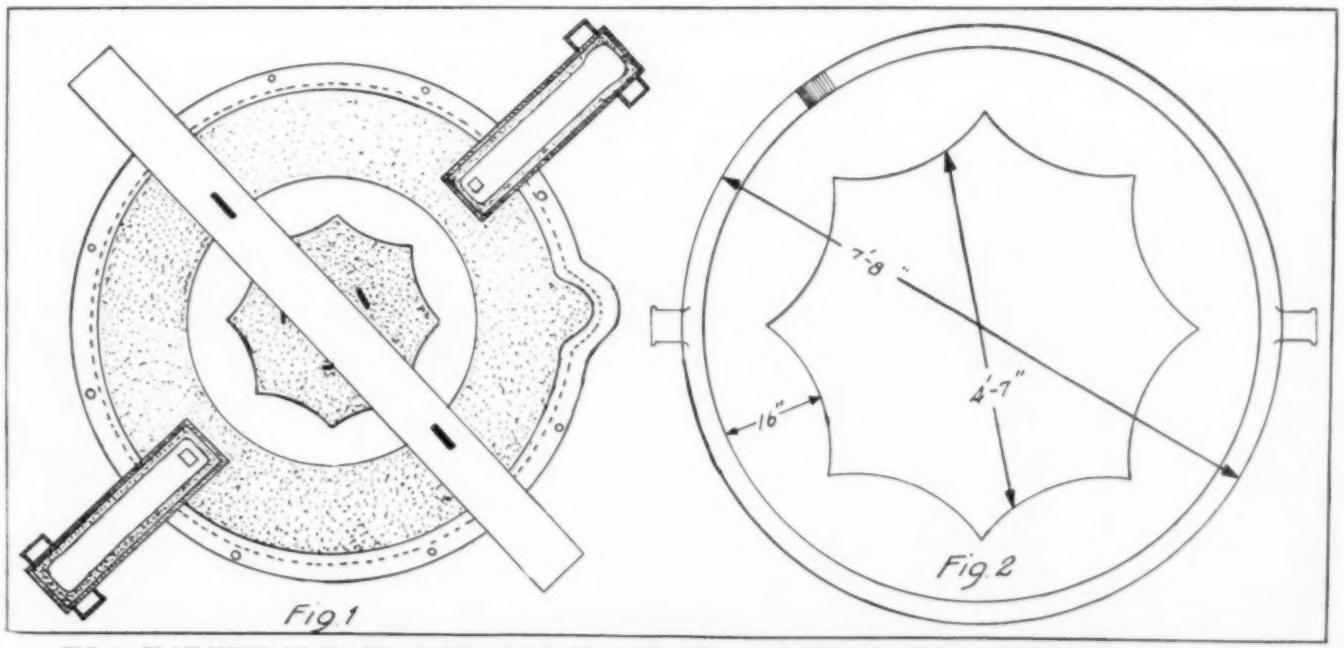


FIG. 1—PLAN VIEW OF CLOSED MOLD READY TO CAST FIG. 2—LOOKING DOWN ON THE FINISHED CASTING

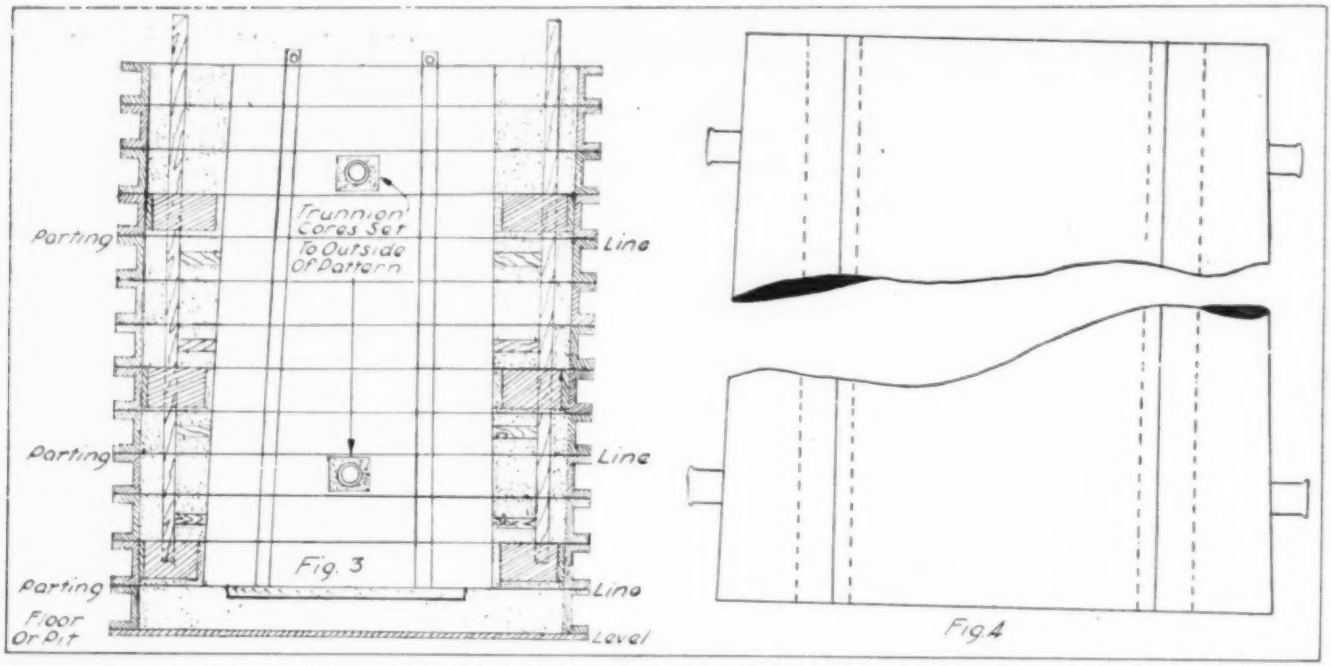


FIG. 3—CROSS SECTION OF RAMMED MOLD SHOWING DISTRIBUTION OF GATES AND PARTING LINES FIG. 4—ELEVATION OF FINISHED CASTING FOUR TRUNIONS ARE CAST ON THE OUTSIDE TO FACILITATE HANDLING

bucket, and shoveled down from there as needed.

Pneumatic rammers are employed exclusively. It is estimated that the time and fatigue saved by their use on a job of this size is approximately 50 per cent. An estimated time allowance, with a bonus for its reduction, insures the close attention to business of both journeyman and apprentice, they in turn keeping the helper busy by their united efforts. To quote from Kippling's "Certain Maxims of Hafiz:"

"With a "weed" among men and horses,
Verily this is the best,
That you work him in office or dogcart,
Lightly, but give him no rest."

The ramming completed, the sprue sticks are drawn out, the mold and pattern hoisted away from the drag at one operation, and lowered fairly level on a set of heavy blocks on the shop floor. The pattern then is forced down by the simple expedient of slowly lowering a long weight of 2 or 3 tons down upon a little packing or a flask part placed on the pattern. A couple of pieces of flat iron placed on the flask edges prevents damage to the mold by the descending weight in the event of the crane driver not checking its drop in time.

Poured in a Pit

The mold next is parted at each joint, each section first being marked to show the correct pin holes to prevent mistakes when finally assembling the mold. The inlet gates are drawn in, and the whole surface thickly blackwashed and slicked prior to the usual oven drying. After the mold is dried, the drag part is lowered into a pit about 9 or 10 feet deep. The core then is set to place and centered from the walls of the first cheek section. A fireclay roll on every joint and tight bolting eliminates the risk of a run out while pouring.

The coremaking needs little comment, save that a divided vertical corebox is used, strongly braced to insure perfect contour. The slightest deviation from correct internal design, swells or scabs, would cause the ingots to stick, and prevent their removal from the mold. For the same reason, steel facing compound is used on the lower half of the core. The sand is rammed around a tapered column with a flanged base. A number of cast iron reinforcing rings are lowered

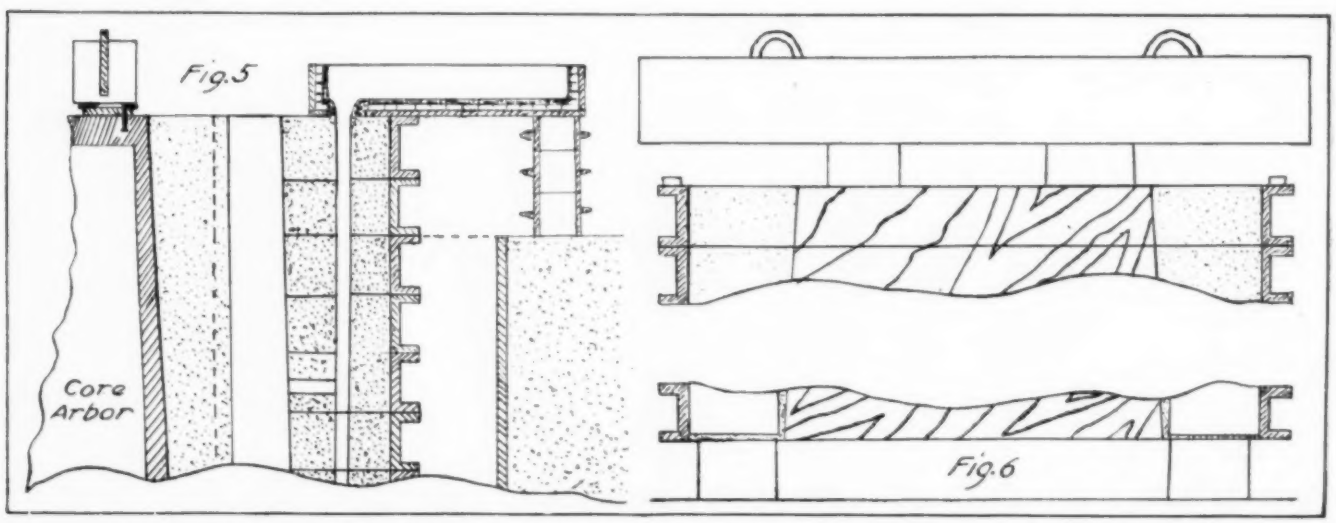


FIG. 5—CROSS SECTION OF CLOSED MOLD SHOWING METHOD OF SUPPORTING OUTER END OF LONG RUNNER BASIN. FIG. 6—THE PATTERN IS PUSHED DOWN A SHORT DISTANCE AND THEN THE CHEEKS ARE LIFTED OFF, BLACKED AND FINISHED

into the corebox and wedged to the column at suitable intervals.

As shown in Figs 5 and 6, the mold is poured from two sides, from two 30-ton ladles. Cast iron runner boxes of type illustrated are laid from the upper face of the mold to stools or packing on the edge of the pit. The elongated pair of runners are necessary when pouring with two ladles to avoid crane collisions. The runner boxes are cast iron troughs, holed at each end to aid transportation. When bricked on both sides and bottom, loamed up and dried, they will last for months with a little touching up each time they are used. However, the lowest point of the runner box must be kept at a higher level than the highest point of all risers, so that the runner is never left full of metal. The merest skin will adhere to the sides and bottom of the runner, as in the case of a ladle of hot metal.

Close attention to the later stages of open-sand pouring of a piece of this size is necessary to avoid flooding. A halt is called when the mold is 14 inches or so from full, the remainder being later poured in slowly to assist in feeding the casting. A representative analysis of the semisteel mixture follows: Silicon, 1.50 per cent; sulphur, 0.06 per cent; phosphorus, 0.23 per cent; mangenese, 0.85 per cent. These castings were regarded as part of the regular routine and occasioned no comment.

What "One Best Way To Do Work" Means

BY FRANK B. AND L. M. GILBRETH

THE "One Best Way To Do Work" is a phrase that summarizes this method. The best available way of performing the work is discovered, installed and maintained, and through this process, production is increased without waste of either the human or material element.

The discovery and use of the "one best way" is no departure from the procedure of "scientific management." It determines what methods scientific management shall standardize and maintain. It implies not only the intensive study of the material element, in which the metal industry has excelled, but a similar study of the human element. This study supplements the findings of those in the industry with the investigations of educators, psychologists and psychiatrists outside industry. Installing and maintaining the results of the investigations requires the use of the entire mechanism of management, with an emphasis on supplying the necessary incentive and reward, if that durable satisfaction is to result which keeps the entire process in operation.

Careful Observation

The "one best way" is discovered through motion study and fatigue study. "Better ways" of doing work, or ways that appear better, may be discovered by more or less careful observations, but if the "best" way is to be found and the improvement is to be measured and maintained, motion study and fatigue study *must* be used. Without these, a method may be thought to be better, which is really no improvement, or a method which really is better may be tried and rejected because the proofs of its excellence are not at hand.

The user of a method is almost never able to judge of its fatigue as compared with another method. The interference of old habits will render the results so unsatisfactory to the user as well as from the production standpoint that the method is likely to be discarded without being used until it becomes a habit and produces satisfaction to the user and uniformity to the product. The "one best way" provides for measurement and maintainance until it has demonstrated its superiority.

It also provides for continuous and cumulative improvement. We hear much in these days of the necessity of "stimulating inventions," of "extending an opportunity for the creative spirit," etc. These *must* be provided for. Under this plan, they are provided for through the mechanism of the suggestion system, which has an important part in the development of the "one best way," and which never performs its highest functions except in connection with the "one best way."

The "one best way" to do work, then, supplies an aim for efficiency, a summary of its results and a method for its evolution. We have seen, as yet, no foundry that does not offer opportunities for saving. We have seen, as yet, no foundry that has derived the "one best way" and is using it, or that is undertaking such derivation.

In our work of discovering occupations for handicapped, we investigated foundry operations in co-operation with the Red Cross Institute for the Blind. We found there craft skill and diversity of operations—an ideal field for motion and fatigue economy. We were able to discover certain processes fitted for blinded workers, and also to make a survey which showed the foundry to be a field for standardizing processes and increasing output enormous in its possibilities.

The day must come when every foundry will undertake to standardize yes, super-standardize, its processes. Results will come quickest if, instead of undertaking the work separately, the foundries combine to establish a laboratory and to make the fundamental investigations for the entire industry. You know that apprenticeship methods are medieval; and that work methods are unstandardized, inefficient and wasteful! You know that craft knowledge, craft skill, and engineering knowledge are not conserved and transferred in the industry as they might be.

The "one best way" to do work has proven itself an efficient method wherever it has been scientifically and persistently applied. It has demonstrated itself as successful in many diversified activities, including those of the foundry. It does not do away with or depreciate, or underestimate the results of past successes or individual achievement. It does not entail introducing strange and alien factors into foundry development. It is a method applicable by any who desire to use it, and who are willing to learn to use it. It not only *must be* used, ultimately, for permanent success; you *have* used it, unknowingly perhaps, wherever you have been successful. You will gain most and quickest by using it scientifically.

Study the Records

Measure and record what you do. Study your records. Determine the most efficient method. Note opportunities for improvement. Improve wherever possible. Lay out lines for further improvement. Install and maintain conditions which insure the best available method being practiced, taught and improved as opportunities offer. This is the outline of the method involved by the "One Best Way to Do Work." This method is applicable to the foundry. It remains for you to decide *when*, *where* and *how far* it shall be applied, and your decisions will influence not only your own industry but national and international prosperity.

From a paper presented before the Columbus convention of the American Foundrymen's association. The author, Frank B. Gilbreth, conducts a consulting engineering office at Montclair, N. J.

Improve Practice in Radiator Shops

Slight Changes in Equipment and a Thorough Organization of the Work Increases Output—Cores Made Without Stiffening Rods—Same Pattern Used for Cope and Drag

BY H. E. DILLER

SPECTACULAR changes have been made in the casting industry during the past fifteen or twenty years and the modern foundry with its multiplicity of machinery and equipment has a radically different appearance from the shops of the past where the wheelbarrow was the chief transportation medium and molding machines where they existed were crude. Sand conveyors in the larger foundries now carry the molding sand directly to hoppers above the molders' benches and complex molding machines turn out vast quantities of molds.

In the manufacture of radiator loops little has been done in the way of developing complicated machinery with the exception of a few companies. One firm operated a system of molding and sand conveying, known among the radiator shops as the *ferris-wheel* system. Another some years ago built a molding machine which not only made the cope and drag, but set the chaplets and cores, closed the molds, carried them to the pouring station, then shook them out, deposited the castings on cars and returned the flasks to the starting point. This machine was extremely complicated and never got into production work although it did succeed in producing a few castings. Because of the immense amount of sand required and the ease with which the light molding machines can be moved along with the sand row, sand conveying equipment is not commonly used in radiator plants.

The successful changes in mechanism have been slight, but these innovations together with a rearrangement of the molding and pouring operations have succeeded in greatly increasing the output per man. Years ago one molder, *buddying* with another made 38 to 40 links a day, one in a mold. A rollover board with the drag pattern on one side and the cope pattern on the other was used. Each molder set his own cores, poured his own molds, and cut his own sand, leaving it in a long row and in the morning started to mold at the end of the row, moving along with his pattern as the molds were made. Now a molder makes 80 molds a day and each mold forms two loops instead of one. Thus the molder makes 160 loops compared to 38 or 40 by the old method. However, he uses a movable flask-lift machine and does not set cores, pour the iron nor cut the sand. Specialists set the cores and pour the metal, one man being able to set cores for molds made by a number of molders

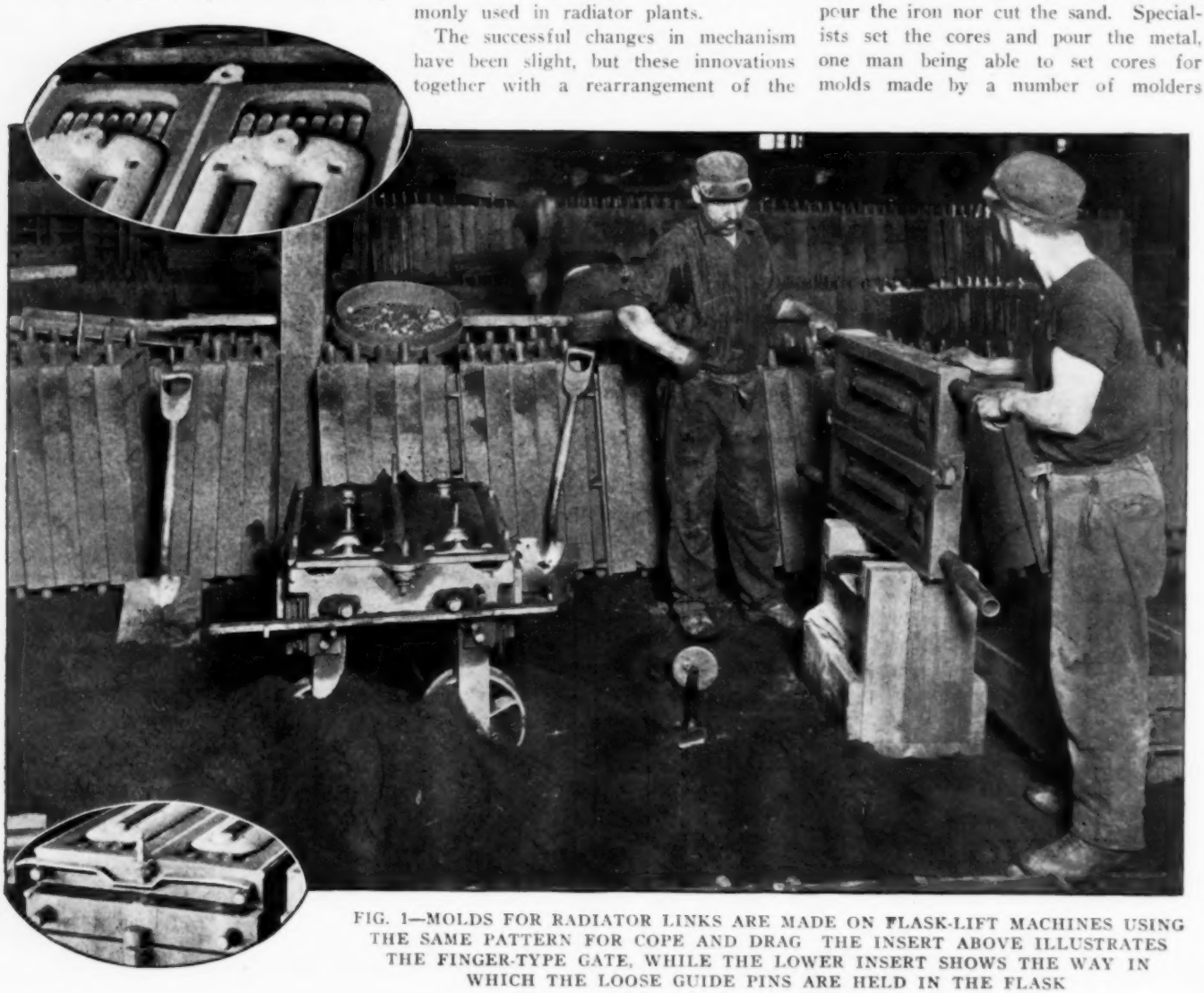


FIG. 1—MOLDS FOR RADIATOR LINKS ARE MADE ON FLASK-LIFT MACHINES USING THE SAME PATTERN FOR COPE AND DRAG THE INSERT ABOVE ILLUSTRATES THE FINGER-TYPE GATE, WHILE THE LOWER INSERT SHOWS THE WAY IN WHICH THE LOOSE GUIDE PINS ARE HELD IN THE FLASK

and the pouring off gang takes care of the entire shop. In this way a man may be trained quickly to operate a molding machine the main requirement being to ram the sand properly, the shallow pattern drawing easily as the machine lifts the flask. Core setting is more difficult than molding as the cores must be exactly in place, but most shops have inspectors who frequently measure the distance between the core and the mold to insure that the cores are being set properly. Pouring off also requires considerable training as the men must work in gangs and pour the various sizes of radiators at different speeds.

FIG. 2—CORES ARE STACKED AT THE END OF EACH ROW OF MOLDS

Another way the work has been made easier is by lightening the equipment wherever possible; a few ounces off each core dryer, a slightly smaller flask, and numerous other changes along the same lines have made the handling work easier. Too, the molders no longer carry the iron in hand ladles, but it is brought to the molds on trolleys or some other mechanical conveyance.

Handling the Charge

The operation of the plant of the Continental Heater Co., Dunkirk, N. Y., illustrates the modern method of producing radiators and boilers. This plant was built about 6 years ago and advantage was taken of the most modern methods in radiator production. The building is of steel frame construction with brick walls and steel sash. Two monitors in the roof carry off the smoke and steam from the poured molds.

The stock yard is covered with a 5-ton traveling crane with a 75-foot span, built by the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. The runway is 195 feet long and extends above an overhanging platform on the level of the charging floor. Pig iron is unloaded from cars by magnet and each car is piled separately. To get it to the charging floor it is stacked on wooden skids and lifted by the crane. The skids are taken to the charging floor by hand lift trucks made by the Lewis-Shepard Co., Boston. Here the charges are weighed on a platform scales and the pig iron is charged into the cupola by hand. The sprue is brought to the charging floor in wheelbarrows and after being weighed is forked into the cupola. Coke is lifted to the platform by the crane in boxes which are handled by the lift truck. An elevator also has been installed to carry material to the charging floor. With this elevator available a breakdown of the crane would not seriously interfere with conveying the stock to the cupola.

The mixture is made up of pig iron together with all the home scrap and sprue made by the foundry. Silicon in the iron is kept around 2.0 per cent and produces a metal soft enough to machine easily. The phosphorus is held between 0.5 and 0.6 per cent to give the metal fluidity. Sulphur is kept as low as possible and seldom goes over 0.1 per cent, while manganese averages about 0.6 per cent.

Cupola Features

Originally two cupolas were installed at one side of the shop, the one lined to 45 inches and the other to 54 inches. Later a larger cupola with a 66-inch lining was erected on the opposite side of the molding department. This cupola now is used almost exclusively. The melt is started shortly after noon and metal runs from the cupola continuously from then until the end of the heat. The method of handling the iron is illustrated in Fig. 4 which shows the cupola being prepared for the day's run. The spout which is constructed in two hinged sections is shown open. Before the heat is started the two halves of the spout are brought together and clamped. The brick *A* act as a diaphragm to hold back the metal and skim the slag. With a 1¼-inch tap hole the metal and slag run freely from the cupola. The slag, being held back by the firebrick diaphragm flows off the spout *B* while the metal flows off a spot at

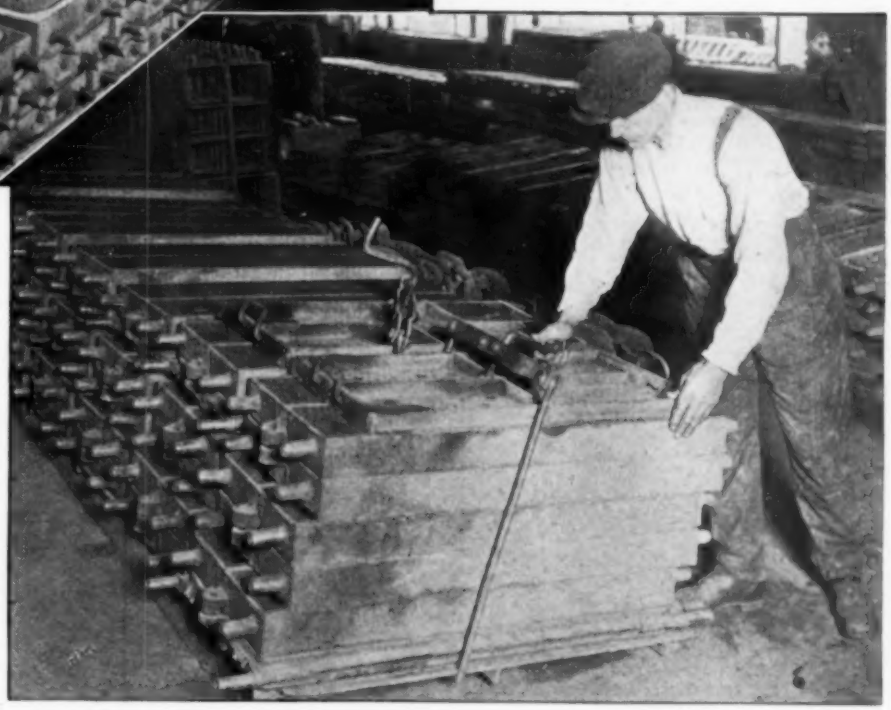


FIG. 3—THREE MOLDS ARE CLAMPED TOGETHER FOR POURING—THE LOWER MOLDS EXTEND SLIGHTLY BEYOND THE EDGES OF THE ONES ABOVE TO EXPOSE THE POURING GATE

the end of the basin. This latter is not shown as it is on the section turned back. The end of this section also has a tap hole at the lower edge. This hole is kept closed during the heat and is opened at the close to allow all the metal to flow out.

Mixing Ladle Used

The mixing ladle, shown in front of the cupola is tilted either way by the hand wheel shown to the left, which is geared to the ladle. In this way pouring ladles can be brought to both sides of the mixing ladle by trolleys traveling on I-beams and carrying chain hoists. It may be noted in the illustration that the chain hoist not only is attached to the yoke of the ladle, but one of the chains also is connected with the handle. This prevents the ladle from tilting. The metal is carried

FIG. 5—THE DRAGS OF THE SMALL BOILER SECTIONS DIFFER FROM THE COPES ONLY AS TO THE GATE

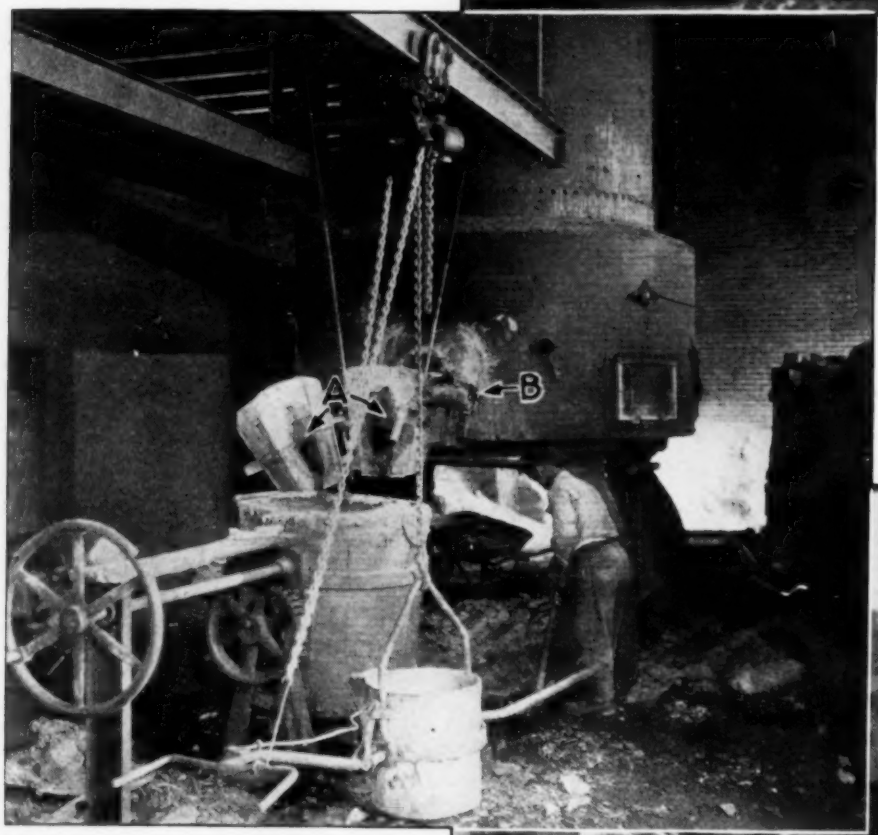


FIG. 4—A NOVEL CUPOLA SPOUT SKIMS THE SLAG FROM THE IRON

to all parts of the shop on a system of I-beams. The two beams which are shown at the cupola extend entirely across the shop and other tracks branch off at every aisle.

The ladles are 700 pounds capacity and all have skimming spouts to prevent slag from entering the molds. However, with the skimming gate on the cupola and skimming spouts on the mixing ladle little slag reaches the small ladles.

The blast is not put on the cupola until after the noon hour so the men who pour the iron act as molders in the morning. Pouring only requires four men. Therefore, the other molders continue molding all day.

All the molding machines for radiation, of which the company has 13, are of the type shown in Fig. 1. Two men operate this particular machine, but the machines which make the smaller loops are operated by one molder. Two of the latter machines are placed together so the molders operating them can assist

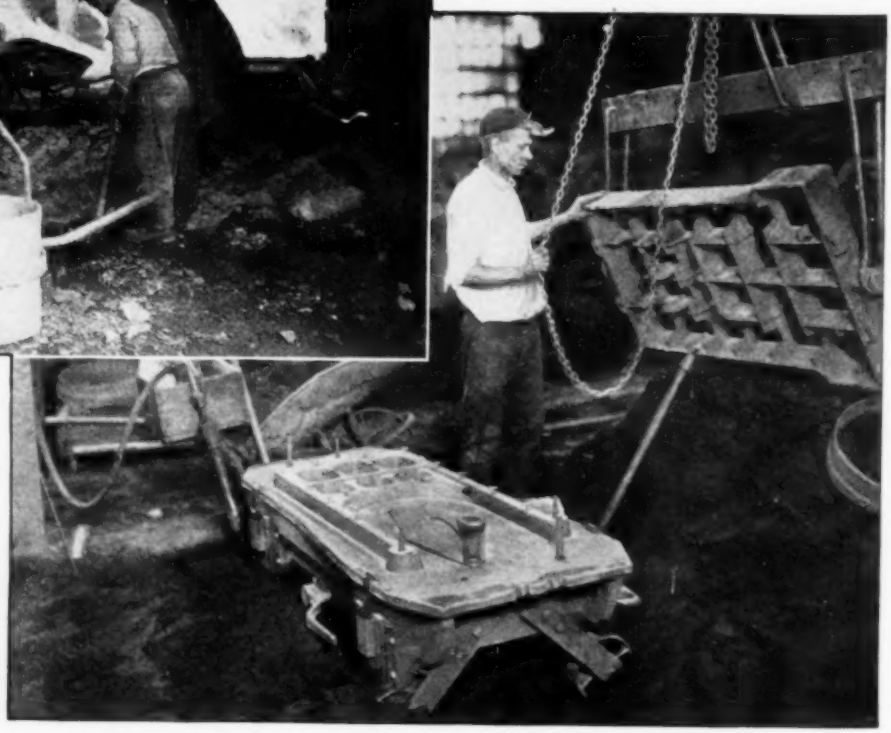


FIG. 6—THE COPE PATTERN, SHOWING THE GATE AS IT DIFFERS FROM THE PORTION OF THE GATE IN THE DRAG, FIG. 5

each other in lifting off the flasks. As may be noted in Fig. 1 the machine is on wheels so that it may be moved along as the sand in front of it is used and the molds are stacked behind it. These molds are stacked three high for pouring.

To make the mold, parting is first shaken over the pattern to prevent the sand from sticking. In winter, the pattern is kept from sweating by heating it beneath with a gas flame. The gate sticks and the chaplets are then set. The points of the chaplets are put into holes in the pattern and the broad base is surrounded with the sand which is shoveled into the flask. This sand is then tucked around the edges of the flask bars with the pean end of the rammer after which the sand in the entire flask is rammed with the butt end. After striking off the top of the mold the gate pins are withdrawn and pipes are put on the four handles of the flask. By pulling a lever, two lugs on each side of the machine are raised and carry the flask with them. It then is lifted by two molders. If it is a drag it is turned over on the bench as indicated in Fig. 1, but if it is a cope it is carried to the drag it is to cover.

FIG. 7—THE CORE FOR THE LARGE BOILER SECTION IS SET BY FIVE MEN

Interchangeable Flasks

All the flasks for each size link are carefully machined and the guide-pin holes are located accurately so that they are interchangeable. The same flask can be used either for a cope or a drag. The guide pins also are interchangeable and when one mold is closed, the pins are lifted out and put in another drag. One of these pins in place is shown in the lower insert Fig. 1. The finger type of gate used on some molds is illustrated in the upper insert. As the cope is made from the same pattern as the drag, the upper section of the gate is of identical construction as that shown in the drag and so a basin above the finger gates is formed and serves to trap any slag which might have found its way into the pouring gate. Another method of pouring is through a long heavy runner at the end which is connected to the casting chamber by two broad runners with extremely thin outlets. This is sometimes called a feather gate.

A number of drags are made first and one of the molders who sets the cores has an opportunity to get the mold ready for closing, set the cores and put square tinplate pads on the core for the tips of the chaplets in the cope to rest upon to prevent the core from rising when the metal is poured. The importance of the accuracy of the length of the chaplets may be estimated when it is considered that the thickness of the metal is only 5/32 inch, the cores being a shade under 1½ inch thick. As has been said an inspector occasionally measures the height of the chaplets to insure the correct thickness of metal will be obtained.

Cores Set Rapidly

Every convenience must be extended to the molders setting the cores as they must work fast, only two molders being employed in setting the 2000 cores needed for the molds put up on 13 machines each day. To have the cores convenient to the molds, they are brought from the core room by the monorail system in wooden carriers having two loose boards across the front to hold in the cores. Some of these carriers are shown in Fig. 2, standing at the ends of the rows of molds.

The molds for pouring are stacked three high, with the lower mold on a perforated cast-iron bottom board, as shown in Fig. 3. It may be noted that each tier of molds is placed a little back of the one beneath it to clear the pouring basis. In this way the lower molds may be poured first and then the upper ones. They are clamped for pouring by placing a cast-iron perforated cover plate on the top mold and tightening it

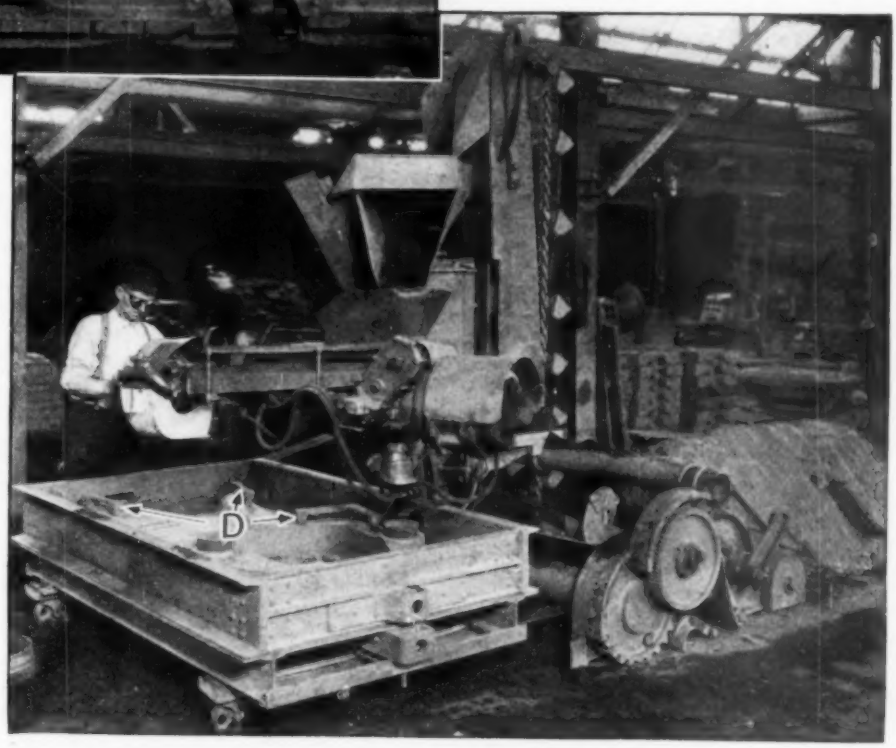


FIG. 8—THE MOLDS FOR THE LARGE BOILER SECTIONS ARE MADE BY A SAND-THROWING MACHINE—NOTE THE ARBORS AT *C* FOR SUPPORTING THE CHAPLETS

FIG. 5—METAL IS POURED INTO THE MOLD THROUGH A GATE AT EACH END AND CARRIED ENTIRELY AROUND THE MOLD IN A RUNNER, ENTERING THROUGH NUMEROUS SHORT GATES

with a yoke hooked to the bottom board on both sides and pressed against the top mold with a screw. In Fig. 3, one of the pouring gangs is shown tightening the screw on one set of molds. Two sets are poured at a time and the clamps are then removed and placed on the next two. In this way six molds with two loops in a mold are poured from each ladle of iron.

The radiator loop, the largest of which is 38 x 9 inches, may be made two in a mold without any mechanical handling device, but the boiler sections are so much larger that equipment must be provided for handling the molds. Fifteen different sizes of these sections are made by the company to form 254 boilers of different capacities. All of the sections are 7 inches deep, but vary in weight from 185 to 825 pounds, the largest being 36 inches high and 6 feet long. The 7-inch cross section is, of course, cored and has 5/16 inch thickness of metal in the walls.

The smaller size boiler sections are made on two flask-lift machines similar to those used for radiator links. However, the flasks are carried on a yoke attached to a trolley by a chain hoist. A difference in the molding from that practiced in making loops is that after the sand is rammed with the hand rammer, the molder goes over the surface with an air rammer to pack it thoroughly. With these castings, as with the loops the same flask is used for either the cope or the drag. However, the gate is different in the two sections as may be noted from the drags shown in Fig. 5 and the cope pattern shown in Fig. 6. The metal flows through the cope and is distributed by the runners in the drag to the legs of the boiler section.

Molding the larger boiler sections must be handled differently from that of the smaller sections as the flasks are a great deal larger and much more sand must be handled. Notwithstanding the size of the flask which is 4 x 7 feet, 10 inches high in the cope and 7 inches high in the drag, the principle of taking the machine to the sand instead of bringing the sand to the machine is used. The machine which is of the sand-throwing type was built by the Beardsley-Piper Co., Chicago. It travels on a track 150 feet long. The molding floor is covered by a 3-ton crane built by the Whiting Corp., Harvey, Ill. The crane has a span of 30 feet with a runway 176 feet long.

At first a sand-throwing machine of the stationary type was installed, but the work of bringing the sand to this machine was found to be too laborious. The movable-type machine travels under its own power, propelled by an electric motor operating a gear on a pinion track, as may be noted in Fig. 8.

Gang Operates Machine

Four molders and a foreman are required to operate this machine, and these men together with two others who prepare and help set the cores make 17 molds a day. Arbors which act as buttons to support the chaplets are first set on the pattern, as indicated at *C*, Fig. 8. Facing sand then is sifted over the pattern and after a little backing sand is thrown in by the machine the sand is tucked around the arbors and into the corners of the pattern by hand. The flask is then ready to be filled with sand which is done by moving the head of the sand-thrower over the mold several times, filling in a few inches each trip around. After the flask is filled with sand, the top is struck off and vented with a vent wire. Then a wooden bottom board is placed over it and the mold is raised by the crane and set in place. All of the drags are made first

FIG. 10—LINKS ARE CLEANED BY PASSING THEM ON A BELT UNDER TWO SETS OF REVOLVING BRUSHES, TURNING THEM AFTER THEY PASS THE FIRST SET

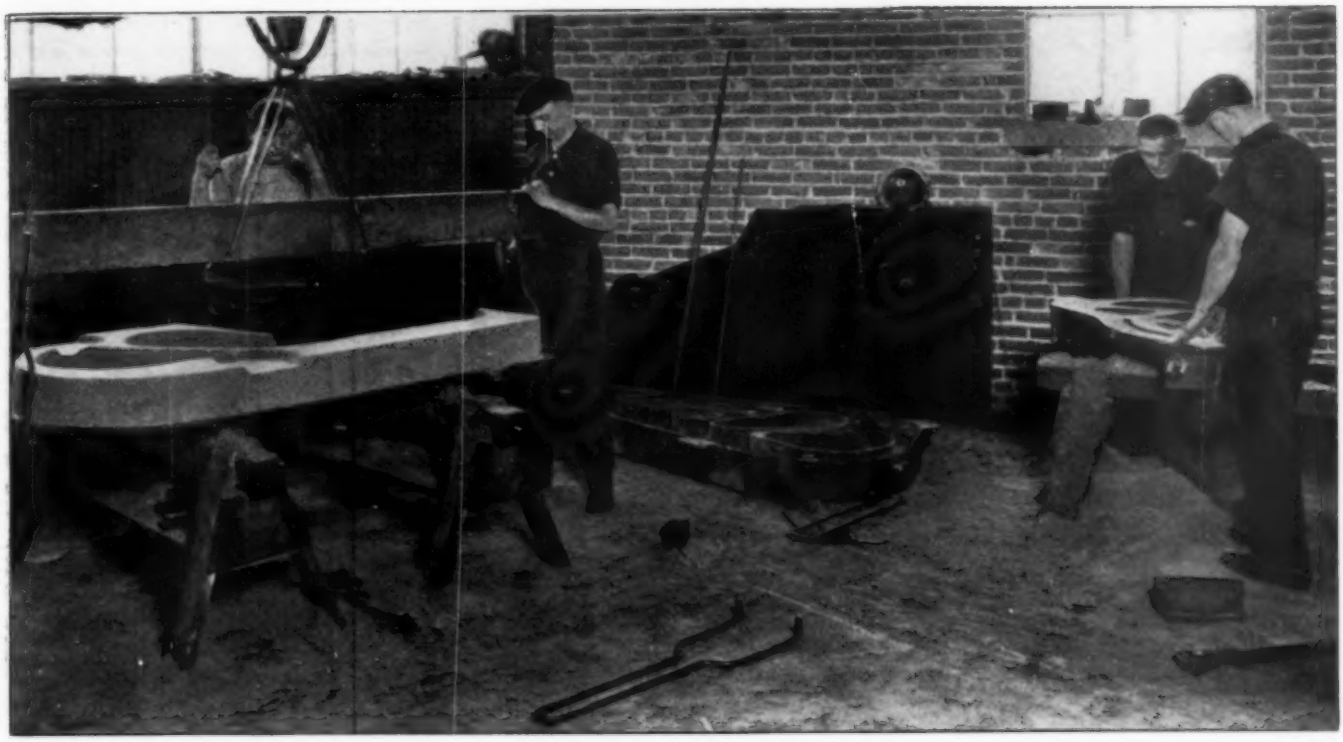


FIG. 11—LARGE BOILER-SECTION CORES ARE HANDLED IN THE CORE ROOM BY A YOKE OPERATED BY AN AIR HOIST

and the cores set before the copes are made. Fig. 9 shows one of the drags ready for the core. The buttons of the arbors for supporting the chaplets may be noted in the bottom of the mold. The two gates also may be seen at each end. The metal comes in these gates and flows entirely around the mold in the groove shown and enters the mold through the 19 runners as indicated. Portland cement is dusted over the mold before the core is set.

FIG. 12—THE RADIATION COREROOM IS ARRANGED FOR RAPID OPERATION—PLENTY OF SAND IS PLACED BEFORE THE COREMAKER AND A RACK TO RECEIVE THE CORE IMMEDIATELY BEHIND HIM

FIG. 13—THE LINKS ARE PRESSED TOGETHER TO FORM THE RADIATOR ON AN HYDRAULIC PRESS, MALLEABLE IRON NIPPLES BEING USED TO JOIN THEM

The theory of this practice holds that the cement picks up water from the sand of the mold and stiffens, forming a hard, thin crust on the mold.

Fig. 7 shows the main core being set by five men. These cores are made in cast-iron boxes which are handled by a yoke carried on an air hoist as indicated in Fig. 11. Here the dryer has been put on the core-box which then was turned and lifted off, being set on the floor behind as shown. At the right may be noted two coremakers forming a smaller core for a boiler section, which does not require an air hoist for lifting it.

Speed Attained in Core Room

The cores for the radiator loops are made in an adjoining room. These are produced rapidly, one coremaker turning out as many as 650 of the largest size cores which go in the molds for the 38 x 9 inch loops. The sand is mixed with an oil compound made by Spencer Kellogg & Sons, Buffalo. The sand is wheeled from the mixer which is set up in a corner of the room near the coremakers and shoveled upon the benches. Fig. 12 shows the front of the benches with the core racks behind the coremakers. A corebox forms one-half the core and the dryer forms the other half. The two are set beside each other on the bench and the coremaker scoops up with his both hands and arms enough sand to fill them. He then tucks the sand in with his hands, strikes it off and forms the two vent lines with the cast-iron print as illustrated in Fig. 12. The two halves then are put together, the corebox taken off and the dryer with the core is put on the rack behind the coremaker. This is a simple operation as no stiffening rods are necessary as was the case in radiation manufacture some years ago.

When the racks are filled they are carried to one of the five core ovens used for the radiator cores, and are baked 2½ to 3 hours at 350 degrees Fahr. as indicated by thermometers attached to each oven. It is essential that this time and temperature be exact as the core must be baked so hard it will not be broken up by the molten metal poured against it, and also will withstand the strain until the metal sets.

In addition to the five ovens used for radiation cores, the company has one other coke-fired oven which is used for the large boiler cores. These ovens each hold three racks and were built by Holcroft & Co., Detroit. Five gas-fired ovens are used for small boiler cores.

Besides the radiator loops, and boiler sections the company makes grate bars and a few smaller castings. The latter are carefully hand-molded on the floor while most of the smaller castings are made on squeezer machines.

The night gang shakes out the molds, stacks the flasks conveniently for the molders, carries the castings to the cleaning department and cuts the sand. This is done with a sandcutting machine built by the American Foundry Equipment Co., New York. The machine piles the sand in long rows of the correct height so that the used sand makes room for the machine to be moved ahead as the molds are put on the floor behind it.

The castings are carried to the cleaning department on skids which are handled easily on the monorail system. Here the first operation is to knock off the chaplets and allow the core sand to run out after being loosened by a few taps of the hammer. As the chaplets are knocked off, the loops are piled near the cleaning machine. This consists of an endless belt passing under two sets of revolving wire brushes. Iron cleats are attached at intervals along the surface of the belt to hold the loops above the belt so that the brushes will not wear it. The machine is operated by three men as indicated in Fig. 10. One workman places the links on the belt and they are carried under the first set of wire brushes under the hood. The laborer standing between the two hoods turns the loops over as they pass. In this way the other side is cleaned by the second set of brushes.

Assembling the Castings

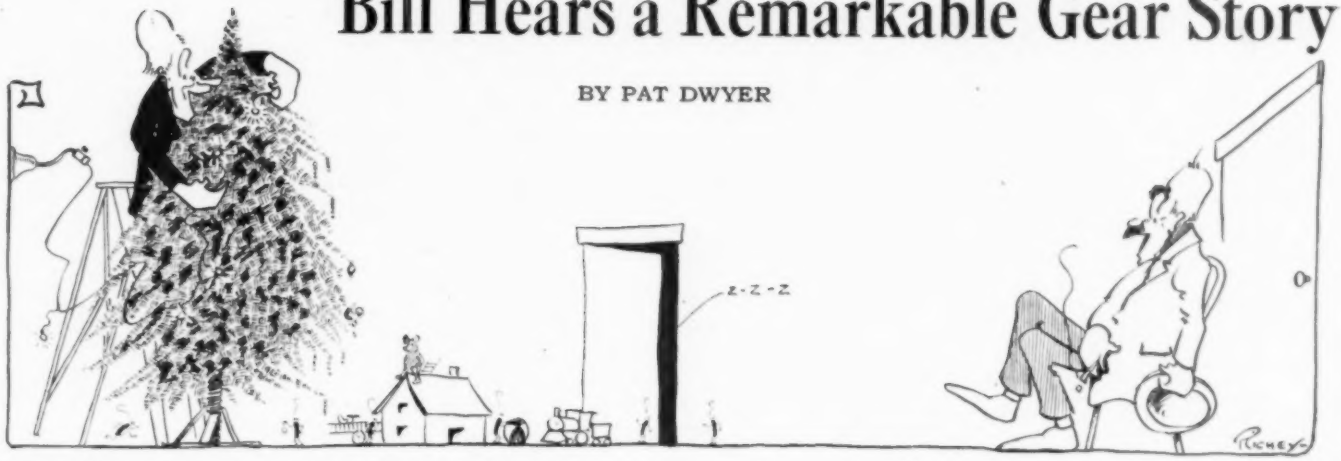
The foundry is by no means all of a radiator shop, as the castings must be machined, assembled and tested. At the left, Fig. 13 is shown one of the hydraulic assembling machines. After the loops are machined they are brought to the assembling room and malleable iron nipples coated with a cement paint are pressed into the tappings. A number of loops to make up a radiator section are placed on the press and pushed together. Usually several radiator sections are on the press at the same time. Care is taken in painting the nipples to see that no paint gets on the inside of the nipple because it would be washed off by the steam and would then clog the system. After the radiator is assembled, it is taken to the testing floor and connected with the water tap after the outlets have been closed. Any leak in the casting or in the connection is indicated by this test. Malleable-iron nipples are also used for joining the smaller boiler sections, but gray-iron nipples are used in the sections for the larger boilers.

The relative areas needed for the different departments in a radiator shop is indicated by the space given to these departments by the Continental company. In this shop the foundry department proper takes up 28,160 square feet of floor space while the total floor space of the shop exclusive of the office which is in a separate building is 57,344 square feet. This area is divided as follows: Two core rooms 4640 and 1280 square feet, respectively; cleaning room 2016 square feet; testing and assembling 1535 square feet; and the radiator and boiler machine shops 9216 and 10,496 square feet, respectively. The offices are in a two-story building adjoining the foundry.

Berlin's automobile show, the first since 1911, marks the complete reentry of the German automobile industry into world competition. At the same time the German makers opened their speedway, the only one of its kind on the Continent, which undoubtedly served as an immense attraction to the show.

Bill Hears a Remarkable Gear Story

BY PAT DWYER



THE night before Christmas on Bill's invitation I had called at his home to see the Christmas tree and other decorations he had rigged up for the benefit of the numerous little ones who call him *Pate*. In addition to his other qualifications Bill is a bit of an amateur electrician and on this occasion he had achieved a gorgeous display of multi-colored lights not only on the tree itself, but festooned from the chandelier to the corners of the room. He told me that *The Missus* had gone down town and had cautioned him to leave the job alone until she returned so that it might be done properly.

"You know how it is," said he confidentially. "there never was a woman who thought a job was done right unless she did it herself. Even if the job is beyond her capacity physically, she still believes she knows how it should be done and in the majority of cases she is willing to express her opinion along those lines not only to the person who attempts the job, but to any person willing to listen and in extreme cases she does not care whether or not any person is listening, she proclaims her opinion to the world.

Of course there are exceptions to this rule. Who ever heard of a rule which had no exceptions? For instance, during the period of courtship when matrimony seems imminent and possibly for a week or two of the honeymoon, she may be willing to admit openly that the object of her choice has several human attributes and occasionally may be right in his opinion, but afterward,—Oh! boy. Again she may make a mistake and hook up with one of these perfect men who carry their small silver in a little change purse and speak sharply if they come home and find a book lying on the dining room table. One of those birds who assumes an icy politeness when he discovers her coat or hat hanging on his particular hook. One of those supermen with such a profound and abiding faith in his own judgment that he insists on having a voice and a majority voice at that,—in the selection of his wife's clothes."

"Well," I said "What's the answer; where do you fit in?"

"Why," said Bill with a grin "I'll tell you. We kinda split the thing fifty-fifty. When the Missus is home I listen to her advice and suggestions and do any little jobs she wants done in the way she wants them done, and when she is away I do them to suit myself. During the course of a long, and I trust, not wholly misspent life, I have learned a few things and one of them is that the man who always waits for someone to tell him what to do, never does much, or gets very far. I have had to tackle jobs many times with no precedent to guide me and with no person in authority to offer either advice or instruction. Sometimes I came out all right and sometimes I slipped, but in either case I learned a little more about the business so that even the failures could not be written down as a total loss. I have adapted rigging and made many castings under peculiar circumstances, but I met a man the other day who told me of an experience he had back in the '90s that showed me I was only an amateur.

"Brought up in a little town in the Middle West, he started to work in the local foundry and being naturally of an inquisitive, inventive, mechanical turn of mind, the owner did not keep him confined in the foundry, but employed him in the pattern shop and machine shop as occasion offered. He afterward had studied engineering and had worked several places in varying capacities when he was made an attractive offer to go down to Old Mexico. He laughed over the experience while telling me the story the other day, but he also admitted that he would not consider a similar proposition today. He was young and limber and full of pep in those days and a 400-mile horseback ride once a week apparently had no effect. However, he is willing to admit that when he finds it necessary to take a little exercise now he has not the slightest desire to take it on horseback.

"On the strength of the prospector's report, a company was formed to develop a silver property in the State of Sonora, Mexico. The president of the new company was acquainted with the young engineer and felt that as master mechanic, he would be a decided acquisition to the force he was organizing to send down to equip the mine and erect a reduction plant. The young man, with the enthusiasm of youth and your true mechanic's pleasure in tackling a new and difficult job, welcomed the opportunity of visiting new scenes and incidentally increasing the scope of his knowledge. The fact that the proposed destination was 200 miles from the nearest railroad and that it was only 5 miles from an abandoned property on which the entire crew had been wiped out by a raiding party of Apaches a few years previously, was brushed aside as a matter of no consequence. The further fact that probably he would be marooned there for two years with no other company than a few officials and a number of Mexican workmen did not lie heavily on his mind. With the unfailing optimism of youth he reflected that he had years and years of a long life ahead of him and a couple of years more or less really did not matter one way or another. He accompanied the initial shipment of tools, supplies and machinery and upon arrival at the Mexican

HE IS BOSS WHEN NO ONE ELSE IS HOME

railroad station arranged for a mule train to pack the goods to the company's property. During the following month or six weeks he established what he considers a long distance horseback riding record, comprising four round trips between the railroad station and the mine, a total distance of 1600 miles. He had to do this on account of the peculiar prevailing railroad rules which would not permit any goods to be unloaded from the cars unless a duly accredited agent of the owner or consignee was on hand to receive them personally and receipt for them. He appointed a resident Mexican agent to see that the freight was unloaded, but that was as far as the agent was willing to go. He refused to accept responsibility for storage and also refused to hire mules and drivers to carry the goods to their destination. Even if the agent had been willing to arrange all these details, he was not in a position to make up the loads in an intelligent manner. The material was required at the plant in orderly sequence to facilitate erection and installation, and as only a limited number of mules were available it was necessary that the material should be examined and marked so that it would arrive at the plant in the order in which it was needed. Quite a force of workmen had been assembled and our young friend did not intend that they should sit around for days at a time calmly viewing piles of machinery because, for instance, the anchor bolts had not arrived, to allow them to go ahead with the foundations.

"He had a set of drawings, but on account of the peculiar conditions involved in shipping the material so far on muleback, his ingenuity was taxed at times to the limit to decide how to make the loads. Each load was limited to 300 pounds and on that account the larger pieces of machinery had been made in sections to be assembled and bolted together later. With all the stuff dumped off the train and piled in a miscellaneous heap, it was no boy's job to sort it out and designate the order in which the various loads should be made up. He had many interesting experiences during the erection of the plant and the installation of the boiler, engine and machinery, but the full test of his ingenuity did not come until some time after the place was in operation. Certain spare parts were kept on hand, but occasionally an accident happened that threatened to shut the plant down until a part could be furnished by the Chicago firm that had supplied the outfit. This meant a delay of at least two months and it was upon occasions of this kind that our friend's inventive genius and mechanical skill manifested itself.

RIDERS OF THE PURPLE SAGE

"In one instance a 3-foot gear wheel on the reduction roll train broke in such a manner that repairs were out of the question. He had to have a new wheel and after wiring to Chicago for a new one he decided to rig up a temporary foundry in which to mold and cast a wheel. He had neither pattern, flask, cupola, ladle, blower, coke nor pig iron, but in spite of all these handicaps, he made not only one wheel, but three and had the mill running nearly two months before the imported casting arrived. It is not likely that a description of the methods employed will be of any direct service to you or any other person, for it is extremely unlikely that you ever will find yourself in a like predicament, but as an example of ingenuity backed by a knowledge of the fundamentals of founding in metal it is about the most interesting that has been brought to my attention.

"None of his Mexican workmen ever had seen a foundry or had the slightest idea of how castings were made; but outside of actually making the mold which he did with his own hands, he found that they were quite intelligent and adaptable and followed his instructions in a gratifying manner. So much so in fact that by the time he had the mold ready, the cupola also was ready and in a condition to melt the iron. He set one man making a cope, another making the fan, a half dozen found employment erecting and lining the cupola, while another gang prepared a quantity of charcoal. He never had seen charcoal made; but some place, some time in his omnivorous reading, he had seen the process described and he passed the instructions on to his workmen as he remembered them. The plant was located in a deep gulch the sides of which were covered with scrub oak and he had no difficulty in securing all the wood he needed. In fact it was the only fuel available and in addition to other uses also was employed for firing the boiler that supplied steam to the engine.

"Before starting the job, he had explored the vicinity and discovered a deposit of sand which to all appearances would answer his purpose. It seemed to be a little coarse, which assured porosity, and when he squeezed a ball in his hand it had that peculiar body, hang and feel by which a molder recognizes sand that will make a firm mold and that will *lift* well in the cope. One of his men dug a quantity, packed it in a

" 'TWAS THE NIGHT BEFORE CHRISTMAS AND ALL THROUGH THE HOUSE NOT A CREATURE WAS STIRRING"

ROUTINE ANALYTICAL METHODS

(*Continued from Data Sheet No. 410*)

In Plain Carbon Steels

Add to a 5 gram sample 80 c.c. acid mixture, made by adding to 1025 c.c. H_2O, 275 c.c. HNO_3, conc. then 200 c.c. H_2SO_4, conc. Evaporate to fumes of sulphuric acid, cool, add 10 to 20 c.c. HCl and about 100 c.c. H_2O. Heat until iron salts are dissolved, filter, wash ignite, etc. as for cast iron.

Weight of SiO_2 x 9.4= per cent silicon (Si).

Notes and Precautions—Any excessive *baking* will cause separation of iron oxide and consequent difficulty in resolution.

The addition of HCl before the water makes solution easier and requires but a few moments. If water is added before HCl there is a considerable tendency to form basic or hydrated sulphates which are hard to dissolve. For extremely accurate results re-evaporation of the filtrate is advised.

Excessive boiling of the silica solution should be avoided as it promotes formation of colloidal silicic acid and soluble silicates.

The silica should be allowed to settle and the majority of the solution poured through the paper by decantation.

The papers should be fitted carefully to the funnel, so that bubbles will not pass. A funnel with a constricted neck and an angle as nearly 60 degrees as can be obtained is of advantage. The inside diameter of the constriction should be about $\frac{1}{8}$ inch. The longer the stem the greater the *pull* on the paper and the quicker the filtration. (Whatman No. 31 and 41 papers are satisfactory.)

The hotter the HCl wash and water the quicker and more complete the washing. It is possible to test the washings for iron, but experience will enable one to do washing and yet waste no time.

The gelatinous silica precipitate will not go through the paper unless the latter is broken, therefore, for routine work a trough may be used to carry off the filtrate. This should be made of lead and placed under the funnels in the rack, sloping to the sink. As gelatinous silica is nearly invisible against a white background it is necessary to scrub the casserole with a rubber policeman and wash the last adhering silica into the paper or to clean the inside of the casserole with a damp filter paper.

The muffle furnace is the best apparatus for burning the silica free from paper and graphite. The door of the muffle should be left partly open to facilitate oxidation. If ignited over a burner a slow stream of oxygen will cause quick oxidation. However, there is a possibility that some of the light precipitate may be blown out of the crucible by the oxygen. If the silica appears gray, it was probably ignited too quickly at first. If the paper is fairly dry the ignition takes little time. If colored gray, break up the precipitate and reignite. Red indicates iron.

The most accurate and only really satisfactory method is to volatilize the silica with hydrofluoric acid. A blank should be run on any unknown acid as some are high in residue. It is especially necessary to volatilize if aluminum or titanium are present.

(*Continued on Data Sheet No. 412*)

ROUTINE ANALYTICAL METHODS

(*Continued from Data Sheet No. 411*)

If desired a factory weight may be used in weighing out the sample. Thus, if a 0.94-gram sample is taken, the weight of SiO_2 x $\frac{100}{2}$ = per cent silicon.

The ordinary time for a complete determination is about 1½ hours, for routine work. The maximum limit of allowable error on duplicate is 0.03 per cent silicon plus or minus in 2.0 per cent. The ordinary error is about 0.02 per cent plus or minus or better. The United States bureau of standards samples vary plus or minus 0.05 per cent with different analysts.

The foregoing method is a modification of Drown's method. It is generally applicable to all gray cast irons. No volumetric method for determining silicon is practical. Among other gravimetric methods may be mentioned, (1) solution in HCl-HNO_3, (2) solution of chilled shot in strong HCl, (3) volatilization in a current of chlorine gas. Per cent silicon is also judged roughly and indirectly by (a) depth of chill, (b) shape of molten shot when dropped into water.

DETERMINATION OF MANGANESE

Principle—The manganese in cast iron occurs largely as the sulphide (MnS) and as the carbide Mn_3C, or as double carbide of iron and manganese. The manganese is oxidized to permanganic acid by sodium bismuthate, ammonium persulphate, or lead peroxide. The permanganic acid is then titrated with standard sodium arsenite. The following general precautions must be observed:

The permanganic acid should be cooled as soon as purple is fully developed.

It must not be allowed to stand too long and must not be exposed to sunlight.

Organic substances and hydrochloric acid spoil results, as do any other reducing agents.

Excess of nitric acid destroys permanganate, especially when permanganate concentration is fairly high.

Sodium Bismuthate Method

Solutions

Standard sodium arsenite—A stable solution can be made by dissolving 3 grams c.p. sodium arsenite plus 6 grams c.p. Na_2CO_3 in 10 liters of water. Also, a stronger solution can be used. If sodium arsenite is not available dissolve 5 grams arsenious acid plus 25 grams Na_2CO_3 in 200 c.c. hot water and dilute to about 10 liters. The arsenite solution is most conveniently standardized against a standard sample of the United States bureau of standards. Theoretically, 1 c.c. $\frac{N}{10}$ $KMnO_4$ equals 0.011 gram manganese but sodium arsenite cannot be standardized directly against $KMnO_4$. Solution made from arsenite and water is somewhat unstable, seeming to vary with the temperature.

Reaction

$$2\,HMnO_4 + 5\,Na_3AsO_3 + 4\,HNO_3 = 5\,Na_3AsO_4 + 2\,Mn(NO_3) + 3\,H_2O$$

Sodium bismuthate is the most certain oxidizing agent. Traces of HCl spoil the results.

(*Continued on Data Sheet 413*)

THE FOUNDRY DATA SHEET, JANUARY 1, 1922
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form

bag on his back and dumped it in a pile on the spot where a hole had been dug in the ground to serve as a molding pit.

"He used the old casting for a pattern; but since the wheel was to be mounted on a shaft at a definite fixed distance from the shaft carrying the pinion in which it was to mesh, it became necessary to provide for the contraction. Furthermore, many of the teeth were broken and part of the rim was missing. He solved both factors of the problem by wrapping a piece of leather belting around the face, thereby converting the pattern into a blank gear and prepared a segment of six teeth attached to an arm designed to swing on a spindle, to form an entire new set of teeth. The arm and segment were laid out to a radius that would compensate for the contraction and produce a wheel of the proper diameter.

"Core prints turned to fit closely in the bore, top and bottom for part of their length, and ¼-inch smaller in diameter for the remainder of their length, were inserted in the casting, which then was placed on a prepared level sand bed in the bottom of the hole. The mold was rammed in the usual manner, the cope taken off and finished and then the broken casting was lifted out of the sand. A round pin, the same diameter as the core print, was driven firmly into the center of the drag. The segment arm, provided with a hole near the end the same size as the pin, was lowered into place and moved around successively until all the teeth had been made up. The center core made in halves and pasted was made of sharp sand, bonded with flour. After the mold was closed and the runner made the cope was weighted down with a miscellaneous collection of pieces of machinery.

"The cupola was erected about 4 feet back from the mold and was made up of a corrugated iron shell lined with adobe bricks. The shell, bound around with baling wire, was about 4 feet in diameter by 10 feet high. A 12-inch lining reduced the inside diameter to 24 inches. The inside was built up solid to a height of about 4 feet with the exception of an air chamber 12 inches in diameter across the bottom. This chamber was continued up through the brick work and terminated in two openings, or tuyeres, on opposite sides and about 6 inches above the bottom. A 12-inch conduit, also built of adobe brick, led from the air chamber in the bottom of the cupola to the point where he had erected the fan.

"The blacksmith made a rotor with 6 arms and to these arms the carpenter had fastened flat wooden paddles about 2 feet long. This fan was mounted in a wooden casing provided with a round opening at each side and a third opening at the bottom, discharging into the brick conduit. A small pulley on the fan shaft was connected by a leather belt to a large pulley mounted on an old discarded wooden windlass barrel. The barrel was mounted between two upright posts set in the ground for the purpose and was provided with two crank handles, one at each end, set 180 degrees apart in relation to the throw. A crowd of Mexican workmen were paired off in relays to furnish the power for operating the fan. They stood in line on each side of the windlass barrel. The first pair gripped the handles and whirled them as rapidly as possible for a few minutes, then they made way for the second pair, and so on consecutively, until all the iron was melted.

"An expedition was organized to visit the scene of the Indian massacre and from the abandoned plant a supply of scrap iron was collected sufficient for their needs. This was packed back to their own plant, broken into small pieces and carried up to a stage built, flush with the top of the cupola. When the scheme of melting iron first had suggested itself he had been somewhat doubtful of the feasibility of using adobe, or sun dried bricks, for a cupola lining, but after he had seen buildings made of this material, some of them dating back to the days of Cortez, and Coronado, and showing no signs of deterioration after the lapse of several centuries, he decided they were reasonably safe. The result of his trials fully justified his expectations.

"A small brick reservoir built in front of the cupola spout was provided with an opening near the bottom, in front through which the iron ran into the basin built on top of the cope. The reservoir was heated by a charcoal fire before the furnace was tapped and the iron was covered with charcoal until a sufficient amount was accumulated in the reservoir to pour the wheel. Taking everything into consideration the casting did not cost any more than the outside casting cost delivered."

"The story sounds extraordinary" I said "although I have no doubt the events occurred substantially as you have recorded them. If I had time I should like to stay and hear what kind of a story you put up when Mrs. Bill arrives and finds that you have disregarded her instructions."

"Don't worry about me," said Bill "I shall be fast asleep when she arrives and there will be so much excitement in this house tomorrow that she will have her hands full without worrying over the decorations."

New Automobile Foundry Covers Four Acres

Details and general information of the new plant of the Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich., manufacturer of automobile cylinders were published recently in the monthly bulletin of the greater Muskegon chamber of commerce. The company having outgrown the present Nos. 1 and 2 plants, it recently purchased a tract of 200 acres about 1 mile to the west to allow for the construction of large extensions and also of homes for the workmen. The new building was laid out as one of eight units to occupy 80 acres. It embraces approximately four acres under roof and when placed in operation will bring the company's total employes up to 3000 and will round out a daily production of 1,250,000 pounds of castings.

It is stated the foundry will consume more pig iron than any other foundry in the Middle West and that 1500 tons of freight will be handled daily. All material and products will be moved mechanically. Operation will be conducted upon the straight-line principal by having raw material enter the plant at one end, pass through the melting stage and subsequent operations, and the finished castings will be loaded on cars and shipped from the opposite end of the building.

Shadows have been practically eliminated from the interior by the use of 65,000 square feet of glass in the roof and side-wall sash. The roof design is known as the Pond truss and consists of three main sections and interposed ventilating bays. Gypsum tile which is a heat-insulating material is used on the roof. Dimensions of the building are 350 x 420 feet with a roof area of 165,000 square feet. An artesian well of 500,000 gallons per day capacity has been driven on the property.

At the north end of the building a loading dock has been erected to expedite shipments. This platform measures 25 x 420 feet and 12 cars may be loaded from it simultaneously. In front of the platform is a double system of tracks. The company will install for manufacturing purposes 130 electric motors ranging in size from ¼ to 125 horsepower. Approximately 2000 horsepower connected-load current will be required.

Originally the company was organized in 1905, but the present company was not incorporated until 1910. Officers follow: President, D. J. Campbell; vice presidents, G. W. Cannon and F. E. McKee. These officers together with A. W. Torbet constitute the board of directors.

Alloys of Aluminum with Silicon

High Melting Point of Sillicon Has Rendered Difficult Its Alloying with Aluminum—Progress Reported in Handling for Rolled Cast Products

METHODS of producing aluminum on a commercial scale involve the presence in the metal of both iron and silicon in amounts aggregating from 0.5 to 1.5 per cent. Both these impurities are regarded with disfavor, silicon especially being looked upon as a factor in corrosion and brittleness. Therefore, it is interesting to find a series of alloys being developed on a commercial scale in which silicon is introduced deliberately into aluminum as a means of improving its properties and in amounts reaching as high as 15 per cent. Such alloys appear to offer possibilities not only for casting in sand or steel molds but also for forging and rolling.

The properties of the two metals are as follows:

	Aluminum	Silicon
Density	2.68	2.49
Atomic weight	27.10	28.30
Valency	3.0	4.00
Melting Point (Cent.)	659.00	1420.00
Specific Heat	0.218	0.170

Inspection of the relative densities will show that the admixture of silicon actually will make aluminum lighter, an important physical fact which applies only to this metal and to magnesium. The cost and difficulty of handling magnesium have restricted the use of this latter element and it is possible that silicon will take its place. As regards cost, 1 pound of silicon bulks as large as 3½ pounds of copper. so that silicon even at 35 cents a pound is a cheaper hardener than copper at 12 cents. Of course, where castings are sold competitively by weight, allowance must be made for the fact that a 75 pound crankcase poured in No. 12 alloy will weigh only about 68 pounds in silicon alloy.

The earliest significant investigation of the aluminum silicon group was conducted by W. Fraenkel,* in Germany, in 1908. Previous investigators had professed to identify compounds present in the alloys such as Al_2Si_3 and Al_2Si, but these were only deduced by analysis. Fraenkel's constitution diagram shows the characteristics of an eutectiferous series of the simplest possible type with the eutectic at 10.5 per cent silicon. Three years after Fraenkel's study, R. Frilley** working in France made a series of tests on silicon and its binary alloys with other commercial metals. In the first place it was desired to ascertain just how far it was true that corrosion of aluminum was due to the silicon element. Frilley tested the following samples for corrosion:

	Per cent
Aluminum	97.41
Iron	0.26
Silicon	2.33

Corrosion about equal to that of high purity aluminum

Aluminum	97.80
Iron	2.95
Silicon	0.25

Corrosion 166 times as much as high purity aluminum

These tests, of which the above figures are only a summary, indicated that some other cause than silicon lies at the root of the corrosion trouble, which the investigator attributed to iron-silicide. In fact, the 10 per cent silicon mixture was found to behave just the same as pure aluminum, being little affected by nitric or sulphuric acids, but rapidly dissolved by hydrochloric acid or free alkalis. In the form of cast test bars this 10 per cent alloy yielded 32,000 pounds tensile with 2 per cent elongation and after annealing 21,000 pounds with 18 per cent elongation. Above 10 per cent, the alloys become highly crystalline and the properties deteriorate. Magnesium also was added as a third constituent using: Aluminum, 89 per cent; magnesium, 9 per cent; silicon, 2 per cent. This mixture was rolled into rods giving a tensile strength as high as 66,000 pounds with 2 per cent elongation and 43,000 pounds with 10 per cent after annealing.

In 1914, C. E. Roberts* in England made a series of cooling curve determinations to check the conclusions reached by Fraenkel. The constitution diagram practically corresponds with that of the earlier investigator. The eutectic is at 579 degrees Cent. with 10.5 per cent silicon no compound is formed and no silicon held in solid solutions. However, Dr. D. Hanson and Marie Gaylor** recently have shown that silicon remains in solid solution up to 1.5 per cent. The eutectic of 10.5 per cent is conformed with an amended temperature of 570 degrees Cent.

European development of aluminum alloys always has been directed to metals for forging and rolling, little attention having been paid to casting alloys. Early in 1915, H. Schirmeister*** in studying the rolling properties of binary alloys of aluminum with copper, zinc, magnesium, silicon, etc. reached figures of 20,000 pounds with 27 per cent elongation after hot rolling using about 10 per cent silicon. The conclusions were that 5 to 7 per cent was the best proportion for rolling and 10 to 12 per cent for casting. A series of tests for corrosion was made and showed that the alloys generally stood up against solvent action better than pure metal.

The alloys of aluminum and silicon, it will be seen, have already been studied sufficiently to provide a groundwork for their practical use. They offer no new and untried field because experiments upon them have been going forward for 13 years.

The practical use of silicon in aluminum alloys is made a little difficult by the high melting point.**** Where a compound is formed, as $Cu\ Al_2$ in a copper alloy sufficient heat is generated to bring down the metal of higher melting point without fear of burning the aluminum. In the present case no compound appears to be formed, so the mixture must be melted entirely by external heat. However, it is possible to procure commercial silicon-aluminum hardeners in a 50:50 proportion which melts at about 1050 degrees Cent. and can be added in small pieces to the aluminum pot. To facilitate melting and also with the object of yielding a finer grain of metal Dr. A. Pacz,* Cleveland has filed a patent covering the use of a

Fraenkel, W. "Uber Silicums-Aluminium Legierungen," *Zeitschrift fur Anorganische Chemie* LVIII-154, 1908.

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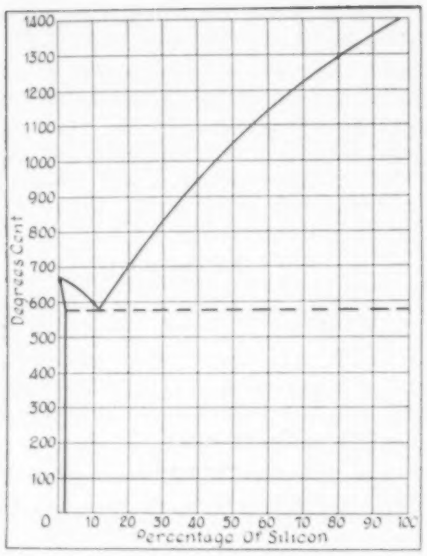

CHART SHOWING MELTING POINTS OF ALUMINUM-SILICON ALLOYS

flux consisting of a fluoride or chloride or a mixture of these. This appears to have the effect of raising the tensile strength to a considerable degree.

High tensile strength is not a primary requisite in aluminum castings and it is probable that too much time has been spent in developing alloys of high tenacity which have been low in other properties. As ordinarily cast, 7 to 10 per cent silicon alloys show about the same tensile strength and elongation as No. 12 aluminum (8 per cent copper); namely 20,000 pounds and 1½ per cent elongation, for sand castings. However, in shrinkage and porosity aluminum-silicon alloys appear to be superior to mixtures at present used in commercial foundries. Shrinkage tests made by Keeps method show the results shown in the accompanying table.

The first four of the results shown were determined in the National Physical Laboratory, England and the last in the test room of an important electrical manufacturer in this country. It will be seen how heavy aluminum alloy is commonly made in order to reduce the shrinkage. The use of silicon attains good results and yields a lighter casting.

Shrinkage of Aluminum

Alloy	*Shrinkage* Per cent	*Pattern Scale*
Aluminum 99%	1.60	1/63
Aluminum 91, Copper 8, Manganese 1	1.31	1/76
Aluminum 88, Copper 12	1.25	1/80
Aluminum 85, Copper 14, Manganese 1	1.21	1/83
Aluminum 93, Silicon 7	1.11	1/90

A small reduction in the solidification shrinkage is of great benefit in the foundry. Molding is simplified chills are reduced and little welding will have to be done. Most important of all, the number of rejections are diminished.

Low shrinkage combined with a relatively high value of hot tensile strength also makes possible castings which could not otherwise have been poured. The remarkable results achieved by the United States Air Service Engineering Division, Dayton, O., in casting an aluminum cylinder around a steel liner have shown that the only alloy capable of standing up to this is the 7 per cent silicon mixture with a small addition of copper. This work which has been done under the direction of E. H. Dix* has yielded conspicuous success. Not only does the casting stand the cooling strains without cracking, but its hot tensile strength at 250 degrees Cent. is over 16,000 pounds per square inch.

Considerable work remains to be done in substituting iron molds for sand in aluminum foundry practice. On a quantity production basis the whole business of molding seems illogical and at least one important foundry has substituted permanent molds and cores, not merely for pistons or small and special castings, but for a motor crankcase and oilpan. Here is an instance where an alloy with the minimum shrinkage, drawing and porosity will open up a new field and up to the present aluminum-silicon alloys offer the best combination of these properties.

Heat treatment of an abbreviated type is beginning to be considered a regular aluminum foundry operation. It is believed to improve the aluminum copper alloys by bringing more of the Cu Al_2 compound into solid solution. The effect of heat treatment on aluminum-silicon alloys has not been exploited, but as the proportion of dissolved silicon is so low in the solid state, it might achieve remarkable results. In any case, the results obtained by Frilley point to this.

Dix, E. H. "Casting Aluminium Cylinder Heads," *Am. Soc. Mech. Engrs. Jour.* 1921

How and Why in Brass Founding

By Charles Vickers

Eliminate Sponginess in Bronze Worm Gears

We are having considerable trouble from segregation and sponginess in a worm gear of the following composition; Copper, 85 per cent; tin, 10 per cent; zinc, 3 per cent; lead, 2 per cent. The casting is of heavy section. The metal on the surface appears sound, the segregation and sponginess appearing near the center. Test bars 0.925 inch in diameter were cast at the same time as the gears and were turned to 0.800 inch in diameter. The following properties were obtained. Tensile strength, 24,000 to 30,000 pounds per square inch; yield point, 17,000 to 20,000 pounds per square inch; elongation in 2 inches, 9 to 14 per cent and reduction of area, 7.5 to 15 per cent. The fracture of the test bar is fine grained, fairly uniform and free from sponginess. Test bars cast from pieces 3-inch in diameter have low properties and show much the same defects as the worms. We wish to obtain sound castings with the following properties: Tensile, 25,000 pounds per square inch; yield point, 18,000 pounds per square inch; elongation in 2 inches, 10 per cent; reduction of area, 10 per cent.

The metal is melted in an oil-fired noncrucible furnace. We have used various fluxes and poured the metal at all temperatures in the range from 1700 to 2250 degrees Fahr. We send you

a sample of the fractured metal and will appreciate your suggestions.

The sample of metal that reached us is loaded with oxides, chief of which is the black oxide of copper, proving the metal was melted in a strongly oxidizing atmosphere. The sponginess of this particular sample is due to the breaking away of the brittle oxides under the tool, and not to gases. However, it is easy to produce holes of varying size in such metal, depending on whether sulphur has access to it. If a small sample of the metal is melted under laboratory conditions and a little sulphur is added, the oxide of copper will be reduced and the metal will "rise" like dough, due to the evolution of sulphur dioxide. If the metal is free of oxides, the sulphur will not *aerate* the metal; in fact, sulphur has been added to cast 88-10-2 without causing porosity, merely to prove the metal was free of oxides.

The first step then is to use a little more oil in melting, thus cutting down the sharpness of the flame; even if it requires a little longer to melt and consumes a little more fuel. Such expense is insignificant in comparison with the defective casting losses.

The alloy is not a good one for a worm wheel. The standard alloy for worm gears is Stone's gear bronze, made as follows:

Stone's Gear Bronze

	Per cent
Copper	87.00
Phosphor copper	2.00
Tin	11.00

The phosphor copper should contain 15 per cent phosphorus. While the above bronze will be lower in elongation than 10 per cent, it will run higher in tensile than 25,000 pounds per square inch. It will be a little more difficult to cut than a leaded alloy but it is eminently more suitable for worm gears.

If it is necessary to have lead in this metal, the following alloy will run more homogeneous than the alloy being used at present.

	Per cent
Copper	86.00
Tin	8.00
Zinc	4.00
Lead	2.00

Use heavy feeders and high heads and pour at a bright orange color. With the phosphor bronze, face the molds, paint with plumbago wash, and dry before casting.

Leave the Aluminum Out

We are making brass elbows or traps and experience difficulty due to dross in the casting spreading from the gate widely into the casting. These castings are U-shaped, about 2 inches in diameter and are used as pipe connections. We gate them at the lowest part of the bend, where a core cuts through to make the drain for the bend. We use an alloy of about 60 per cent copper; 38 per cent zinc, and 2 per cent lead. About one ounce of aluminum is added per hundred pounds of metal. Any suggestions you can offer will be appreciated.

The trouble is due entirely to the aluminum, and without the aluminum, a mixture with 38 per cent of zinc will not run. There are just two things that can be done to eliminate the trouble. One is to change the brass to a mixture that will run without aluminum. The other is to figure a way of placing the castings in the molds, so they will run clean with the present alloy. Change of sand, and change of gate will make not the slightest difference unless the principle governing the clean running of aluminized alloys is understood. An alloy that will run clean without aluminum follows:

Copper, 69 per cent; zinc, 27 per cent; lead, 2 per cent, tin, 2 per cent.

The present alloy will run clean provided the metal runs up-hill into the mold, from the lowest point of the casting, and does not impinge upon any portion of the core or mold. The metal must not drop, otherwise there will be dross. To discover where to gate the casting, hold it in the hand in the position it will occupy in the mold; take the index finger and place it under the widest flange. This is where the gate must be. It will leave a little lump on the underside of the flange. Tilt the molds slightly, so the metal will run up hill into the casting. Take off a riser from the other flange.

Brass Alloys To Resist Frictional Wear

One of our customers manufacturing locomotive cranes has had difficulty with brass friction blocks. They seem to cut very badly. We have tried manganese bronze with extra hardener added and also copper 85 per cent; tin 5 per cent; lead 5 per cent; zinc 5 per cent, the latter giving better service than the former although not at all satisfactory. Just now we are trying 88-10-2 but have no data on its usefulness. We would like to know what alloy would be most suitable for this purpose.

If the conditions under which these castings operate demand a very hard metal, the following phosphor bronze will be serviceable:

HARD PHOSPHOR BRONZE

Copper	73.50
15% phosphor copper	7.00
Tin	12.00
Lead	7.50

If the 88-10-2 alloy now being tried gives better service than the 85-5-5-5 previously tried, it indicates that a hard metal is required and the above mixture will be satisfactory. If the experience with 88-10-2 is more disappointing than with the softer metals, it will indicate a ductile metal is required. In such a case use the folowing.

Soft Ductile Alloy

Copper	92.00
Aluminum	7.00
Iron	1.00

The above alloy will have a tensile strength over 50,000 pounds, with elongation above 50 per cent.

Reclaiming Silver from Table Ware

We would like to learn of a process to employ to reclaim the silver from knives, spoons and such like scrap.

First; clean the flatware by immersing in hot potash or lye, then wash in cold water and dry with hot water. Second; immerse in the following acids;

SILVER STRIPPING SOLUTION

Sulphuric acid	1 gallon
Nitric acid	4 ounces

Pour the nitric acid into a stone crock and add the sulphuric acid; stir well. Hang the flat ware in the solution, and do not allow the pieces to touch each other. The strip can be made to work faster by increasing the nitric acid, but it is better to work slowly. Leave the articles until the silver is removed. The strip will work for a long time, but when exhausted, prepare a solution of 5 gallons of water containing 1 pound of salt, for each gallon of strip. Pour the strip into the salt solution, stir, and allow to settle. Test the clear solution with more salt solution to remove all silver. Syphon off the clear solution and wash the silver chloride in a dozen waters, adding fresh water each time, and allowing the chloride to settle, then pouring off the water.

After a thorough washing, place the chloride in a crock, and pour over a solution of water ten parts, sulphuric acid 1 part, then lay clean, bright strips of galvanized iron amongst the chloride and allow the action to continue several days. The chloride will be reduced to metal; it will show powdery and gray, wash thoroughly in a number of waters and allow to dry, then mix in ten per cent soda ash, and a little calcined borax, and melt in a furnace. The result will be a pure silver. There will be needed, acids, containers, strips of galvanized iron, a furnace and crucibles with tongs to remove them from the fire, and ingot molds into which to pour the molten silver.

Refractories Source of Troubles

Imperfections in Gray-Iron Castings Usually Attributed to Oxidation Said To Be Due To Absorption of Small Amounts of Aluminum and Calcium Compounds from the Refractories or Slag

W. L. MORRISON

COMPLEXITY of research with gray-iron melting is illustrated by the facts brought forward by Mr. Morrison. Burned iron has for a long while been a subject of discussion among foundrymen, and oxygen has been a convenient excuse for defective castings. Now the theory is suggester that much of the iron which previously had been thought to be oxidized was, on the contrary, subject to such a reducing atmosphere that it contained aluminum and calcium carbides which later reacted with the moisture in green-sand molds to form a gas which produced blow holes. This theory is novel and has points to warrant its consideration.

CONSIDERABLE discussion as to the effects of oxygen on cast iron has been given in the past and again the question came up at a recent meeting of the Institute of British Foundrymen in a paper presented by J. Shaw, a review of which appears in the Oct. 1 issue of THE FOUNDRY. While oxygen generally is a source of evil in any metal, results from Dr. Johnson's oxygenation process have given promising results on some irons.

With the introduction of the electric furnace in the foundry, many considered it a cure all for their troubles, so far as the iron is concerned. However, some problems in connection with the use of the electric furnace when used for cast iron must be considered. The effects of continued high temperatures and a strongly reducing slag on cast iron has not been given the consideration it deserves. Much of the so-called burned iron produced from the blast furnace and cupola has absorbed impurities from the slag and these impurities cause the blow holes.

Iron Absorbs Aluminum

The statement is often made that irons with the same chemical analysis often vary in their physical properties, and yet the reports of analyses cover only the usual elements; total carbon, graphitic carbon, combined carbon, manganese, silicon, sulphur, phosphorus and sometimes alloys, if they happen to be present. The complete analysis seldom is made and little significance is attached to other elements than those mentioned, which may be present as impurities.

Much of the so-called burned iron, either from the cupola or from the electric furnace is not due to over oxidation, or insufficient deoxidation, but to the use of poor refractories, a poor grade of pig iron, or bad slag conditions.

The selection of refractories is important and only the best should be used. The selection of pig iron also must be made with care and although the amounts of the common elements; silicon, sulphur, phosphorus, manganese and carbon may be satisfactory, the aluminum and calcium contents should be given consideration, especially the aluminum content.

More or less absorption of aluminum from the coke will take place in the blast furnace, especially when it is working irregularly, and operating at higher temperatures than normal. The writer believes this is one reason why charcoal iron is of superior quality, there being much less aluminum-bearing materials in the furnace per unit of iron produced.

Aluminum and perhaps calcium, up to the present time, have been considered harmless ingredients in cast iron. But the writer believes the absence of these elements gives a stronger iron, and an iron better adapted for chill work. Aluminum added to molten iron in the ladle apparently has little effect on the iron except to influence the ratio of combined and graphitic carbon. If the aluminum is added to the iron and then subjected to the arc of the electric furnace, superheated to considerable extent in the presence of carbon, and then poured into a green-sand mold, the casting on being machined may give the appearance of burned iron and show slag on the cope side. Or if cast iron is melted in the electric furnace in the presence of carbon and an aluminous slag, the iron is sure to be bad unless the total carbon is above 3.60 per cent.

The first attempt to make synthetic pig iron in Portland, Ore., was not encouraging because an aluminous sandstone was used in the charge to furnish the silicon content for the iron. The pigs when cast were full of blow holes although the analysis indicated a fair grade of foundry iron. This iron could be used in the cupola only by mixing it in small proportions with other pig iron and scrap. At the time no reason could be given for the blow holes, but the trouble was eliminated by the use of a high grade quartz which had to be shipped in from northern Washington.

Blow Holes Form

About two years later trouble was experienced with blow holes in cast iron when beginning to pour castings direct with synthetic iron. The trouble occurred only when the melter was having trouble with his heat. When operating with too much slag on the bath, additional slag was formed from the roof and side walls of the furnace, while raising the carbon content, due to excessive heat. Then upon pouring the metal, if the carbon content was under 3.25 per cent, the iron would give the appearance of burned iron, with blow holes under the skin of the metal, if green-sand molds were used. The furnace was first lined with high grade aluminous firebrick. Had the furnace been lined with silica brick, there would have been less slag and no deleterious effects would have been had. No lime was used in the heats mentioned. This iron would be free from blow holes when it contained a high percentage of carbon, but would not be as fluid as metal made under the proper conditions. A scum was noticeable over the bad metal, which is entirely different from that formed on good metal, and this would continue to form after being lifted off by the skimmer. The skimmings were light in color, and on analysis, proved to be almost entirely aluminum and silicon oxides with a small amount of iron.

Mr. Shaw mentions in his paper, already referred to, a similar condition. He described his experience as follows: "When the ladle of molten iron was skimmed, and the usual oxide film covered the surface, numerous small bubbles escaped toward the air and

immediately spread out to the size of a shilling and appeared under these film spots. There appeared to be some chemical reaction taking place accompanied by heat, because these spots were of a higher temperature than the surrounding metal. If the ladle was allowed to stand for a time, as the temperature of the metal dropped, the spots turned black as they came to the surface and spread out. If the oxide film on the top of the metal was now pushed aside, these black patches could be taken from the top of the metal and would have the appearance of hammer scale."

Slag Is Viscous

The only difference noted by the writer is that the skimmings taken from the top of the ladle, while having the appearance of hammer scale when hot, on being cooled were almost white. Also, this thin film upon being taken from the center of the ladle slowly, could be pulled out like glass, as the slag formed on the surface, showing a strongly acid condition of the slag formed. This slag did not come from the ladle linings.

When the trouble was first experienced increased amounts of silicon were added to see if the blow holes could be eliminated, but even with silicon up to 4.00 per cent and carbon 3.00 to 3.25 per cent the blow holes still were in evidence. Analyses of various irons showed the aluminum content to run from 0.4 per cent to 1.25 per cent. The borings from these bad heats, upon the addition of water, evolved gas much more readily than turnings from normal heats.

The writer believes that with the intense heat produced by the arc and in the presence in excess of materials bearing aluminum compounds, carbides of aluminum, or of aluminum and iron, are formed and absorbed. Aluminum carbide being extremely energetic chemically reacts with the moisture in the molds and produces gas holes, giving the appearance of the so-called burned iron.

In cupola practice bad iron often results from the use of inferior fireclays, or running the cupola excessively hot, accumulating aluminous slag which if not properly fluxed and removed, reacts with the coke, especially if the temperature is higher than usual. In such cases the iron is apt to absorb the aluminous materials and produce the so-called burned iron. The writer has noticed that from the same ladle of cupola iron dry-sand castings would be perfectly sound while the green-sand castings would develop small blow holes under the skin of the metal.

A small experiment with vanadium thermit in cast iron recalls a condition which tends to explain the action of aluminum or aluminum carbide on cast iron. A mixture of vanadium oxide and 90 per cent ferrosilicon was made into a capsule and placed in the bottom of a 200-pound ladle. The iron was poured on the capsule and the reaction taking place reduced the vanadium. The iron was then poured into a green-sand mold and a sound casting was secured. A second ladle was poured, placing the same sized capsule on the top of the molten iron in the ladle, after the reaction the iron was stirred and poured into a green sand mold. A good casting resulted. Six ladles were poured using the 90 per cent ferrosilicon, vanadium mixture in varying amounts, and good iron resulted every time.

The same experiments were repeated using aluminum, vanadium-oxide thermit mixture. In every case, the iron upon being poured into green-sand molds, would rise in the pouring gate upon standing, or develop blow holes upon machining the casting. Thinking perhaps the theoretical amount of aluminum was not enough to give complete reduction of the oxide of vanadium, a 10 per cent excess was added. This was increased to 25 per cent, and finally double the theoretical amount was added. In every case blow holes developed.

The iron, after the thermit reaction, was as good as any to all appearances, not showing any signs of being wild or gasing. The untreated castings from the same heat were all good. Stick aluminum was added to the last ladle after the thermit reaction, but gave no better results. Ten ounces of aluminum was added to an untreated ladle of iron which after being stirred well was poured. This iron produced a sound casting, which tends to prove that the iron was all right, and that aluminum as an alloy does not cause the blow holes.

The silicon, vanadium-oxide thermit and the aluminum, vanadium-oxide thermit mixtures were each tried out on small ladles of molten steel before pouring. Good castings resulted with both mixtures. The absence of a large excess of carbon in the steel, as compared to cast iron, prevented the formation of aluminum compounds such as those which caused the blow holes in the iron castings.

Develops Blow Holes

Comparing the results in the electric furnace with the results obtained by use of the aluminum-vanadium thermit mixture, the conclusion reached is that the temperature produced by the aluminum thermit reaction was sufficient to form aluminum carbide in the iron and this reacted with the moisture in the sand. Aluminum carbide is unstable, and active chemically. If the gas in the iron was due directly to oxides being present on account of the vanadium oxide, then one would naturally expect the silicon mixture to give the trouble, because the heat of reaction is much lower than that of the aluminum, vanadium-oxide mixture.

Cupola Experiments Cited

Carl Buberl in the July 1, 1921, issue of THE FOUNDRY, calls attention to the fact that cupola daubing clay affects iron. While Mr. Buberl does not state that the iron absorbed aluminum compounds, he does state that the iron absorbed something from the clay and gave poor castings. When a better grade of clay was used and less slagging encountered, the trouble was less frequent. This all tends to prove my theory that under certain conditions aluminum carbide is produced and is absorbed at high temperatures.

The writer believes that much of the so-called burned iron from the cupola is not due to excess of oxygen absorbed, or present as oxides in the metal, but due to slag conditions, irregular working of the furnace and contamination of the metal by materials high in aluminum.

The only way to overcome this difficulty, both in the cupola and the electric furnace, is by proper selection of refractories, keeping the dry aluminous slag off the metal, and correct fluxing. Various additions to the ladle have been tried, also poling in the furnace with a green pole, but once the metal has become contaminated it must be reclaimed by raising the carbon sufficiently high to overcome the effects of the aluminum carbide or by slight oxidation and subsequent recarburization, or the heat must be cast into pigs. In cupola practice there is no alternative, but with the electric furnace the metal can be reclaimed.

Making steel in the basic electric furnace for green-sand castings gives considerable trouble at times on account of the improper use of the basic slag. There is a possibility that a similar condition to that of the iron exists due to the extremely high temperatures to which steel is heated and the possible absorption of undesirable elements or compounds from the slag. Even in the acid process for steel this absorption will bear investigation especially when using aluminous materials for a bond in making the acid bottom.

While the presence of aluminum and calcium are detrimental to good iron under certain conditions, by proper fluxing and the removal of excess amounts of slag, there should be no trouble from these elements. One rea-

son for going into the discussion is to aid the foundryman in avoiding heats of the so-called burned iron, by use of good refractories, and proper fluxing and removal of slag. Molding sand or core sand, left clinging to sprue and scrap castings to be remelted is detrimental both from the point of furnace operation, and the effects upon the iron, due to the excess of aluminous slag formed.

Can Use Oxygenation Process

The writer believes a benefit is to be derived from the use of Dr. Johnson's oxygenation process, which has perhaps heretofore been overlooked. This is the removal of calcium and aluminum by oxidation rather than the addition to the iron of oxygen as ferrous oxide, or in some other form. The removal of aluminum would raise the combined carbon and perhaps lessen the fluidity of the molten metal to some extent, especially if it is low in phosphorus, but the greatly increased strength would more than offset the detrimental factors.

Part of the great variation in physical properties of cast iron with the so-called similar analyses apparently can be traced to varying amounts of calcium or aluminous compounds present, which heretofore have been considered harmless in small quantities.

The lower operating temperature of the charcoal blast furnace and a fuel of low ash content, practically free of aluminous materials, gives an iron freer of elements absorbed from the slag, than the coke-operated blast furnace of today. The latter is usually driven to its utmost capacity, resulting in higher temperatures, and this with the fuel of higher ash promotes absorption. However, some means may be found to wash pig iron made in the coke furnace, and so raise its physical properties.

The electric furnace is rapidly making its way into the gray-iron foundry as an adjunct to the cupola in the so-called duplex process to refine the iron. However, the writer does not believe the electric furnace can correct an iron which has been ruined in the blast furnace, or during cupola melting, except by the rather expensive method of oxidation and subsequent carbonization.

The electric furnace in the duplex process is used almost entirely as a superheater, and to some extent for desulphurizing and carbonizing. There is a possibility that Dr. Johnson's oxygenation process could be used profitably and with good results for treatment of the cast iron as it comes from the cupola before entering the electric furnace for final treatment. This would remove the excess calcium and aluminum if present in poor iron, and result in a more uniform product.

Care should be used in melting or refining cast iron in the electric furnace, especially when using a deep bath, for if the direct arc furnace is used, the top of the metal may become superheated to such an extent as to cause an absorption of enough elements from the slag to produce bad iron even in the electric furnace.

While no doubt oxygen has some influence on the quality of cast iron, the writer believes, as has already been stated, that much of the bad iron encountered in the foundry is not due to oxygen, but can be traced to other substances derived from the slag either in the blast furnace or in the cupola. These substances, existing in the iron as impurities, then set up chemical reactions in the molten iron after it has been poured into the mold. In some cases where a considerable amount of the impurities is carried in the iron the reactions are noticeable before pouring from the ladle.

While the writer has no direct proof that aluminum exists in cast iron as the carbide, he does know that aluminum goes into cast iron at high temperatures in the presence of carbon, and has a deleterious effect upon it. Also, a dry basic slag if left in contact with the iron too long in the electric furnace is bad for the iron and may cause blow holes.

An excellent field is open for further investigation of the influence of aluminum and calcium compounds in different amounts on cast iron with varying carbon content, at high temperatures such as are attained in the electric furnace.

Establishes Electric Furnace Department

An electric furnace department has been established by William Swindell & Brothers, Jenkins Arcade building, Pittsburgh, under the direct supervision of Frank W. Brooke, late vice president and chief engineer of the Electric Furnace Construction Co., Philadelphia. The new department offers the latest design in electric furnaces for melting steel gray iron and nonferrous metals and a complete line of electric heating furnaces from 30 kilowatts upwards. A license to operate under the Marsh patents for the nickel-chromium electric resistance elements has been granted this firm.

GRAPHITE FLAKE SHOWING INTERNAL NETWORK STRUCTURE

By J. W. Bolton

THE accompanying micrograph of a graphite flake in gray iron shows an internal network structure which accounts for the strength of gray iron, notwithstanding its seemingly almost complete discontinuity. This network, according to H. M. Howe, is largely ferrite. In our research we have shown also the presence of sulphides and have found indications of the probable migration paths of the carbon from the combined to the graphitic state. Others have shown the presence of gases in graphite. The sample shown in the illustration has been heat tinted and is magnified 700 diameters.

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Seek Rational of Semisteel

IF THE foundryman, who is melting gray iron which shows a tensile strength of approximately 20,000 pounds per square inch, adds 10 to 15 per cent steel scrap to his mixture, the strength of the resultant product will be in the neighborhood of 30,000 pounds per square inch. Of course, semisteel like cast iron can be mistreated in the cupola so that its strength will be considerably lowered but no trouble should be encountered in making semisteel of a tensile strength of 30,000 pounds per square inch when using 10 to 15 per cent steel in the mixture. On the other hand, only by using special grades of pig iron made in a cold-blast furnace can gray iron regularly be obtained from the cupola, with as high tensile strength as can be secured in semisteel. This same effect is also obtained to a greater or less extent in malleable iron—the judicious addition of steel to the metal in the air furnace bringing the strength of the resultant product to over 50,000 and in some cases even over 60,000 pounds per square inch.

Reasons have been advanced for this strengthening of the product by the addition of steel to the cupola, but none has been universally accepted in the metallurgical world. One of these is that the addition of steel reduces the carbon in the resulting metal. That the addition of steel in the cupola gives a product with less carbon than would have been obtained is true in some cases only. However, with the addition of only 10 or 15 per cent of steel to the cupola the amount of carbon absorbed from the coke is practically enough to make up for the lower carbon in the original charge. An example of the extent to which steel will absorb carbon from the coke in the cupola is the case where charges made of half 8-per cent ferrosilicon with around 2 per cent carbon and one half steel rails with less than 1 per cent carbon, which would be an average charge of less than 1.5 per cent carbon. This mixture comes from the cupola with as high as 3 per cent carbon and never less than 1.8 per cent. This low-carbon metal sometimes obtained from this mixture might be expected to be unusually strong if the theory that the increased strength is due to the lowering the carbon by the steel additions, but it was no stronger than metal made from a mixture of 10 to 15 per cent steel scrap.

Until recently carbon was considered to exist in iron in either combined or graphitic state. Some distinction was made in the shape of the graphite as effecting the strength of the metal, but otherwise one graphite was looked upon the same as another. However, lately it has been shown that the flakes formerly looked upon as graphite are far more than a simple piece of carbon, but are complicated compounds of iron and carbon in different states. Explanation of this phenomenon is given by J. W. Bolton in a short sketch in this issue of THE FOUNDRY describing the micrograph of a flake of graphite. This opens a field for investigation new to the metallurgists and promises to explain the effect of steel on the strength of cast iron and also to throw some light on the question as to why increase in combined carbon, with its attending lowering of the graphite content does not produce nearly as marked effect on the strength of semisteel or cast iron as might be expected from the rate of increased strength obtained from increasing the carbon content in steel.

Trade Outlook in the Foundry Industry

A GENERAL survey of the surface conditions in the foundry industry gives little indications of the true state of the business situation in the casting trade. Seasonal dullness is manifest in practically every branch of the industry, but indications point to renewed activity shortly after the first of the year. While this increase undoubtedly will come, the rate of operation now is so low that only a marked advance would bring conditions anywhere near normal. Thus, while the surface indications are not bright, fundamental changes in general business and financial conditions mark a decided progress toward economic readjustment.

Fundamentals Improve

Steady lowering of the interest rate for money is one of the basic conditions conducive to a broader activity in the investment and buying field. This works in conjunction with the scaling down of manufacturing costs. One step in the latter direction which was taken on Jan. 1 is the abolishing of the government tax on freight and passenger traffic on the railroads. The cost of freight charges, which enter so largely into the production of pig iron and other materials needed by the foundry, amounts to 3 per cent. Some idea of the extent to which this affects industry in general may be gained from the fact that travelers and shippers on the New York Central lines alone will save in the aggregate about $12,000,000 during the coming year, according to present estimates. However, this is only a portion of what must be accomplished in the reduction of shipping charges. The other source of lower shipping costs is reduced freight rates.

Prices of Raw Material for Foundry Use

CORRECTED TO DEC. 23

Iron		Scrap	
No. 2 Foundry, Valley	$20.00 to 20.50	Heavy melting steel, valley	$14.00 to 14.25
No. 2 Southern, Birmingham	17.00 to 17.50	Heavy melting steel, Pitts.	14.50 to 15.00
No. 2 Foundry, Chicago	20.00	Heavy melting steel, Chicago	11.00 to 11.50
No. 2 Foundry, Philadelphia	20.75 to 21.75	Stove plate, Chicago	14.00 to 14.50
No. 2 Foundry, Buffalo	19.50 to 20.00	No. 1 cast, Chicago	14.00 to 14.50
Basic, Valley	18.25	No. 1 cast, Philadelphia	17.00 to 18.00
Basic, Buffalo	19.00 to 20.00	No. 1 cast, Birmingham	16.50 to 17.50
Malleable, Chicago	20.00	No. 1 cast, Buffalo	17.00 to 18.00
Malleable, Buffalo	19.00	Car wheels, iron, Pittsburgh	14.50 to 15.00
Coke		Car wheels, iron, Chicago	15.50 to 16.00
Connellsville foundry, coke	$3.50 to 4.25	Railroad malleable, Chicago	13.00 to 13.50
Wise county foundry, coke	5.50 to 5.75	Agricultural mal., Chicago	13.00 to 13.50
		Railroad malleable, Buffalo	13.00 to 14.00

Railroads Halt

Following the slight expansion which took place in October and November, when a reduction in railroad wages accompanied by a lowering of freight rates was expected, the iron and steel production has eased somewhat and the gain of 4.3 per cent in the number employed in the steel industry in November over those employed in October probably has been lost in December. However, the reduction in freight rates must come eventually and will be an incentive for more active buying. In the meantime the railroads have reduced their buying of new equipment. Car orders have dwindled considerably in the past few weeks, but several large contracts are pending. In the meantime foundries are obtaining the benefit of car orders placed earlier and are supplying a larger amount of castings for railroad equipment. This is especially noticeable in malleable iron foundries. This branch of the foundry work has eased off slightly in November from the rate of production during October when it was slightly over 25 per cent. While larger orders have come in from the railroad equipment manufacturers and the automobile trade, the amount of miscellaneous business has been lighter. These larger orders from the automobile industry do not necessarily indicate an impetus in the automobile business, but rather that the large stocks on hand have finally come to an end. While a number of automobile shops are closed over the holidays the sales force predict a fair trade in the spring, and the Willys-Overland Co.; Toledo, announce plans to make a large increase in its working force.

Stove Foundries Slack

Gray-iron foundries have been operating at about the same rate as the malleable, and also appear to be working on a lighter basis. Stove foundries which have helped to hold up the average of production in the gray-iron industry are becoming slack, a number of them closing down completely over the holidays. This is also true to a lesser extent of the radiator foundries and those making cast-iron pipe. But a number of contracts for pipe have been let by municipalities and others are pending in New York, St. Paul, Minneapolis, Duluth, Cedar Rapids, Iowa, and Venice, Calif. Foundries supplying other castings used by municipalities, such as fire plugs and valves have been moderately busy, with orders continuing in fair volume. Some improvement has been reported in the demand for castings from the mining districts of Missouri, Kansas and Oklahoma. In New England where the textile industry is active demand for castings has slightly improved. One condition prevails in nearly all foundries in the country and that is a low stock of pig iron and coke, some foundries carrying not more than two weeks' supply. This makes the prospective demand for pig iron larger than it has been. The first buying of size for 1922 delivery has brought with it further concessions in price. One indication of the pig iron market is the tendency to shade or even ignore the silicon differential. Copper, the basic metal of the brass foundry is maintaining its slow but steady increase in price. One noticeable feature of this metal is the large spread between the price of electrolytic and casting copper, indicating that the foundry trade is not using as much of its normal supply as the other branches of industry. This is notwithstanding the brass foundries have been busier than other foundries comparatively speaking.

Nonferrous Prices

Nonferrous prices based on New York quotations in the *Daily Metal Trade* of Dec. 23, follow: Casting copper, 13.00c; electrolytic copper, 13.75c; lead, 4.75c; Straits tin, 32.62½c; antimony, 4.50c; aluminum, No. 12, alloy, producer's price, 19.00 to 19.20c, and open market, 10.00 to 15.00c. Zinc is 4.90c East St. Louis.

Comings and Goings of Foundrymen

CARL B. STONE has been appointed advertising manager of The Cleveland Tractor Co., Cleveland. Mr. Stone who for the past two and one-half years has served the company as sales representative, assistant advertising manager and district sales manager, will take up the work of G. B. Sharpe, who has resigned.

R. L. Agassiz, Boston, has been elected president of the newly organized Copper and Brass Research association.

Horace B. Spackman, president of the Allegheny Ore & Iron Co., has been elected president of the Eastern Pig Iron association.

J. M. McNeal, sales engineer, Landis Machine Co., Waynesboro, Pa., has returned after a year and three months in England and the continent.

Joseph H. Lee has retired, having sold his business, the Providence Brass & Aluminum Foundry, Providence, R. I., to the National Fire Department Supply Co.

Harvey B. Prescott has joined the sales force of Pilling & Co., 71 Broadway, New York. Until recently, Mr. Prescott had charge of the Pittsburgh office of W. J. Rainey, Inc.

George M. Davidson, chemist and engineer of tests of the Chicago & North Western arilroad, has been appointed industrial engineer, continuing his headquarters in Chicago.

William R. Norcross, president of the American Molding Machine Co., Terre Haute, Ind., has been named as a member of the board of public works of that city by the mayor-elect.

Henry J. Karges, Evansville, Ind., prominent stove manufacturer, has been named by Mayor Bosse as a member of the board of public safety of Evansville. He will take office Jan. 2.

C. B. Adams has been appointed vice president and sales manager, and C. H. Peterson, secretary-treasurer and general manager, both of the Maher Engineering Co., 30 North Michigan boulevard, Chicago, mechanical equipment.

John H. Moffett has been appointed associate professor of metallurgy in the University of Minnesota. While employed at foundry work Mr. Moffett took a course at the University of Cincinnati, graduating with the second highest honors of his class.

C. F. Meyer, assistant secretary of the Landis Machine Co., Waynesboro, Pa., manufacturers of bolt and pipe threading machines, has returned from a year's trip around the world. Mr. Meyer's itinerary included India, Java, China, Japan and the Hawaii Islands.

A. A. Albaugh has been made vice president and general manager of the Barnhart-Davis Co., Warren, Pa., manufacturing oil refinery accessories, special machinery, etc. Previously Mr. Albaugh was general superintendent of the Jacobson Machine Mfg. Co., Warren, Pa.

The Foundry 1921 Index

THE complete listing of all articles published during 1920 with cross references and an authors' index has been prepared and will be ready for distbiution within a short time. This will be sent free upon request to any subscriber who requests a copy through the Circulation Department, THE FOUNDRY, *Cleveland.*

Louis N. Burns, for many years sales manager of the J. I. Case Plow Works Co., of Racine, Wis., from which he resigned about a year ago, has been elected sales manager of the LaCrosse Plow Co., LaCrosse, Wis., a leading manufacturer of plows and tractor plows.

John J. Egan, Atlanta, Ga., has been elected president of the American Cast Iron Pipe Co., Birmingham, Ala. Mr. Egan has been connected with the Birmingham corporation in an executive capacity since its organization in 1906, and is one of the principal stockholders.

H. M. Thompson, who was formerly identified with the Thomas Molding Brick Co. has been appointed Chicago representative for the Quigley Furnace Specialties Co., 26 Cortlandt St., New York City. Mr. Thompson will make his headquarters at 105 W. Monroe St., Chicago.

George Wedlake, vice president and general manager of the Cockshutt Plow Co., Ltd., Brantford, Ont., has been elected president succeeding Col Harry Cockshutt who resigned recently to become lieutenant governor of Ontario. Colonel Cockshutt retains his identity with the company as chairman of its board of directors.

Frank K. Bull, chairman of the board of directors of the J. I. Case Threshing Machine Co., Racine, Wis., has tendered his resignation, effective Dec. 31 in order to be free to retire to his country estate in North Carolina. Mr. Bull was born in Racine in 1856, the son of the late Stephen Bull, one of the founders of the Case agricultural implement industry. At 19 he started work in the plant as a machinist's helper. He was elected secretary of the corporation in 1881, and in 1897 he was advanced to president, which office he held until 1916, when he was made chairman. For two years he has not been active. Mr. Bull retains his large holdings in the company following his retirement from official connections.

Honors Past Presidents

Past presidents of the New England Foundrymen's association were entertained at a dinner given by the association at the Exchange club, Boston, Dec. 14. C. L. Newcomb, the Deane Steam Pump Co., Holyoke, Mass., presiding officer during the year 1912, addressed the membership in behalf of his fellow past presidents. These include men who have been most prominent in the foundry industry of New England during the past quarter of a century. The first president, George H. Gibby, Condor Iron Foundry, served during the years 1895 to 1898 inclusive, followed in 1899 by W. O. Barbour, Barbour-Stockwell Co.; 1900 and 1901, George B. Buckingham, Arcade Malleable Iron Co.; 1902 and 1903, Henry A. Carpenter, A. Carpenter & Sons Foundry Co.; 1904, B. M. Shaw, Walker-Pratt Mfg. Co.; 1905, John Magee, Magee Furnace Co.; 1906, Walter B. Snow, B. F. Sturtevant Co.; 1907, William H. Bense, Kinsley Iron & Machine Co.; 1908, Henry F. Arnold, American Tool & Machine Co.; 1909, William A. Viall, Brown & Sharpe Mfg. Co.; 1910, Joseph L. Anthony, Weir Stove Co.; 1911, H. E. Wetherbee, Jas. Hunter Machine Co.; 1912, Charles L. Newcomb, Deane Steam Pump Co.; 1913, Robert C. Bird, Broadway Iron Foundry; 1914, Charles L. Nutter, Old Colony Foundry Co.;

1915, A. F. Corbin, Union Mfg. Co.; 1916, Stephen E. French, Athol Machine Co.; 1917, T. R. Scott, Brown & Sharpe Mfg. Co.; 1918, George P. Aborn, Blake & Knowles Steam Pump Works; 1919, Robert L. Newcomb, Deane Steam Pump Works; 1920, A. B. Root Jr., Hunt-Spiller Mfg. Corp.

Richard H. Rice, works manager, General Electric Co., Lynn, Mass., gave an interesting address on the present-day need of establishing and maintaining mutual confidence between employes and management, and what a representative industry has done to meet these conditions.

Discusses Metal Fatigue

H. F. Moore, professor of engineering materials, University of Illinois, Urbana, Ill., and in charge of the joint investigation of fatigue of metals of the national research council, engineering foundation and other organizations, addressed the Cleveland chapter of the American Society for Steel Treating on Friday evening, Dec. 9, in the rooms of the Cleveland Engineering society, Winton hotel. The speaker discussed at length the phenomena of fatigue of metals and concluded with a review of the progress made by the investigation up to date. Professor Moore brought out the point that while considerable progress has been made, the solution of the problem has but begun. More than 200 attended the meeting, the Cleveland branch of the American Society of Mechanical Engineers having been invited.

Cost Accountants Form Local Section

Ground work has been laid for the permanent organization of a Cleveland section of the Industrial Cost association, whose aims are to make industrial cost finding methods uniform and to stimulate the interest of all manufacturers in correctly determined costs. At a meeting in Hotel Cleveland Dec. 7, of representatives of plants in this district, in other Ohio cities and of officials of the National Industrial Cost association, those eligible to membership here became associated with the New Cleveland section.

Robert E. Belt, secretary-treasurer of the American Malleable Castings association, Cleveland, and a director of the national association, was selected temporary chairman, and L. J. Flynn, auditor of the Van Dorn & Dutton Co., Cleveland, temporary secretary-treasurer.

It was decided to conduct a campaign until Jan. 19 to interest all officers and managers of industrial corporations, firms, and trade associations in this district, and employes in executive supervision of cost accounting in the benefits to be obtained from such mutual consideration of cost problems. On the evening of Jan. 19 the first actual meeting of the Cleveland section will be held, when a permanent organization will be decided upon.

Albert A. Alles Jr., secretary-treasurer of the national association and one of its founders, gave an interesting history of the organization which was formed a little less than a year ago and which now has approximately 300 members.

J. W. Riddle, assistant chief statistician of the Youngstown Sheet & Tube Co., Youngstown, O.; C. W. Morse, of the cost department of the Falcon Steel Co., Niles, O.; F. E. Rogers, United States Malleable Iron Co., Toledo; M. H. Williams, Browning Co., Cleveland, and others, spoke of the practical results that may be obtained from such an organization.

Obituary

Edward Anger, aged 71, formerly general foreman of the foundry of the Union Switch & Signal Co., Swissvale, Pa. died Dec. 9 in his home in that city. He was born in Pittsburgh Feb. 3 1850 and learned the molding trade at the Reynolds foundry. In 1887 he entered the employ of the Union Switch & Signal Co. being appointed general foreman of the foundry in 1903. Mr. Anger retired in 1915.

Arnold Hinkins one of Chicago's oldest settlers died of pneumonia Dec. 1 after a four days' illness. Mr. Hinkins was born in Holland, came to America in 1849 and settled in Chicago in 1856. At the time of his death Mr. Hinkins was president of the Butler Steel Foundry Co. which he organized in 1891. He was known as the oldest foundryman in Chicago.

Edgar Webster Summers, aged 63, president of the Summers Steel Car Co., Pittsburgh, and nationally known as the designer of numerous devices for loading and unloading ore cars and ore boats, died last night at the home of his daughter in Glenshaw, Pa. He was born in Bellebrooke, O. Mr. Summers became chief engineer of the Wellman, Seaver, Morgan Co., Cleveland, where he developed the modern type of car dumper and ore unloader now in use on the Great Lakes boats.

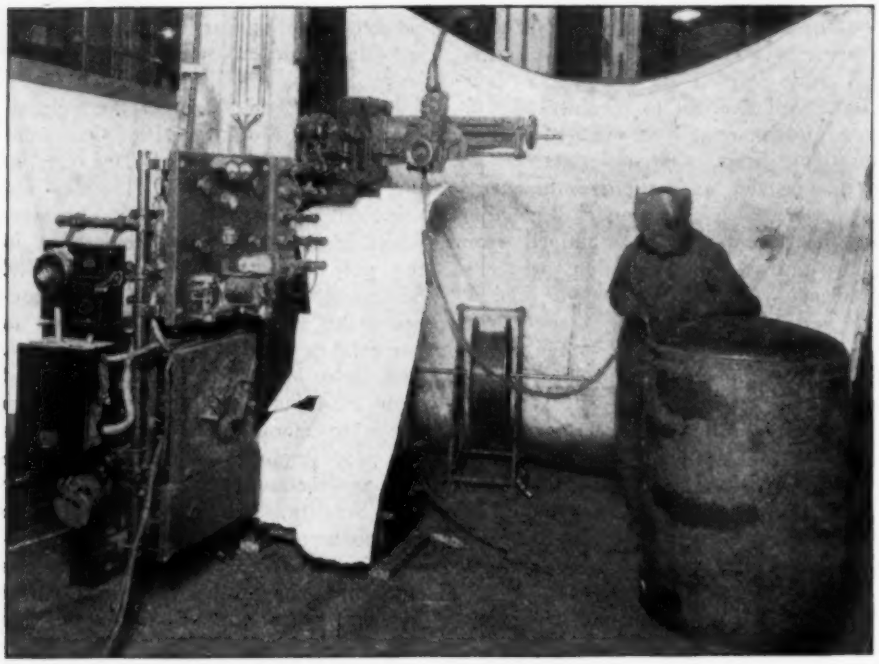
John McClary, founder and president of the McClary Mfg. Co., London, Ont., Canada, died Dec. 11, at the age of 92 years. He was apprenticed to the tinsmithing business when 18 years old, but took part in the gold rush to California in 1849. After operating some time as a prospector he returned to London and in partnership with his brother, Oliver, went into business as a tinsmith and plow manufacturer. In 1854 the firm began to manufacture stoves and this line was gradually expanded until the company became the largest producer of stoves in Canada. In addition to his position as president of the McClary Mfg. Co., Mr. McClary was also president of the Ontario Loan & Debenture Co. and a director of the London & Western Trust Co.

Thomas G. Fitzsimons, one of the pioneer manufacturers of cold drawn steel products, and president of the Fitzsimons Co., Youngstown, O., manufacturer of cold drawn steel, and also of the Finished Steel Co., Youngstown, died in Cleveland, Dec. 9, following an illness of several weeks. Mr. Fitzsimons began his career in Cleveland in the foundry of his father, William Fitzsimons, who was the head of the William Fitzsimons & Sons, with a foundry in Cleveland. It was in this plant Thomas G. Fitzsimons carried on his experiments in cold-drawn steel.

Develops Semiautomatic Arc Welding Lead

A semiautomaticc are-welding lead recently developed by the General Electric Co., for use in conjunction with its automatic arc welding head is shown in the accompanying illustration. It retains the continuous features of the automatic apparatus, yet allows the operator to direct the arc as required by the conditions of the work.

The apparatus consists of a welding tool to be held by the operator. This acts as a guide for the electrode wire. In the handle of the tool, which resembles an automatic pistol, is a switch for operating the control on the panel of the automatic welder to start and stop the movement of the electrode wire. A 10-foot length of flexible steel tubing is attached to the tool, with an adapter on the other end for attaching it to the automatic welding head. The wire passes from the feed rol's of the head into the flexible tube and thence to the arc through a guide nozzle in the



AN ARC WELDING LEAD THAT ALLOWS THE OPERATOR TO DIRECT THE ARC AS REQUIRED BY THE CONDITIONS OF THE WORK

welding tool. The automatic welder functions in the usual manner, tending to hold the arc length constant. The operator merely directs the arc as required by the particular job in hand.

It is claimed that the field of application of the new tool is in the welding of products where the seams to be welded are of irregular contour; or on large work where the travel mechanism and clamping necessary for the full automatic welder would be complicated and costly. In many cases the edges of the seams are not accurately prepared making gaps in some places and tight fits in others. The automatic welder with mechanical travel cannot compensate for these conditions by varying the speed; or by manipulation of the electrode, a feature for which the semiautomatic is particularly adapted.

This latest attachment also may be used for building up metal rapidly as in the case of filling up blow holes in castings; or in building up worn spots, etc. The speed of deposition of the metal varies widely, being between the ordinary hand speed and that of the automatic, according to the conditions of the particular job. In general it is about twice as fast as hand welding.

The advantages claimed for automatic welding equipment may be summed up as follows: Saving in time ordinarily lost in changing electrodes. Saving of from 10 to 20 per cent in electrode material usually thrown away as waste ends. Operators may become proficient in the use of the tool quickly. They do not require the muscular training necessary for hand work. Continuous operation results in few interruptions in the welding, which customarily is a potential source of defective welds.

Signaling Instrument Times Operation

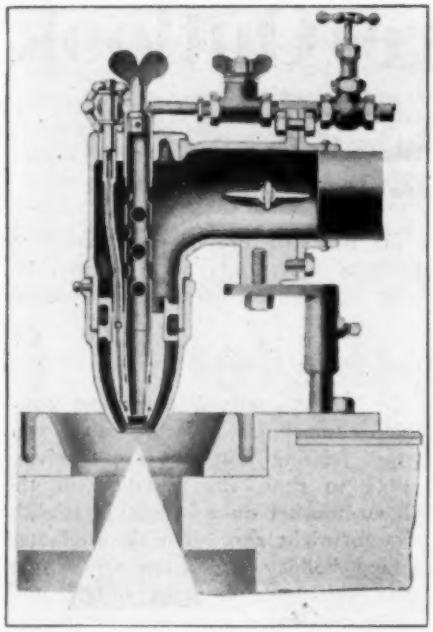
The instrument shown in the accompanying illustration, manufactured by the Stromberg Electric Co., Chicago, has been designed for use wherever the time element constitutes a governing factor in any manufacturing process. It indicates the total length of the process; the length of time a process has been in operation; how much longer the process is to continue and automatically operates a signal when the process is completed. The signal, whether a bell, or light, or both, will continue to operate until stopped by the person in charge. The instrument is driven by alternating current and may be attached to a wall or post at any convenient point. It is stated that the case is designed and constructed in a manner to furnish the mechanism complete protection from dust and moisture and further that the functioning is not affected by heat or cold.

A white dial, 3½ inches in diameter, protected by a glass cover, varies in markings and total time covered, depending upon whether the instrument is to be used for long or short processes. Four standard dials are manufactured and graded according to the maximum length of time required for a definite process. The first has a maximum timeing limit of 3 minutes and 48 seconds, it is graduated in seconds. The second registers 11 minutes and 24 seconds and is graduated in periods of 3 seconds. The third runs for a period of 57 minutes and is divided into 30 second intervals. The fourth can be set to any period up to and including 1 hour and 54 minutes, with subdivisions 1 minute apart. They are uniform in size and general appearance.

Burner Operates on Any Grade of Fuel Oil

To secure perfect combustion from an oil fuel it is essential to have absolute control over the mixing mechanism in order that the carbon particles of the fuel may unite with the oxygen of the air in the proper proportion. It also is essential to maintain the proper temperature at which the carbon uniformly combines with the oxygen. It is claimed that both these conditions are met in an oil burner manufactured by F. J. Ryan & Co., Franklin Trust Building, Philadelphia, and shown in the accompanying illustration. This diagrammatic photograph shows the method of construction and assembly and clearly indicates the method of operation and simplicity of adjustment. It will be noted that in operation the oil finally passes through currents of air coming both from the outside cone and through the center. It is stated that the mixing effect caused by the flow and expansion of the air results in a combined mixture which passes out of the burner in a whirling spray ready for perfect combustion. This feature also makes for ease of lighting either in a hot or a cold furnace and it is stated the short white flame produced is submitted as evidence that practically complete combustion is effected. On account of its simplicity

THE INSTRUMENT IS 7 INCHES HIGH, 5¼ INCHES WIDE, 5½ INCHES DEEP AND WEIGHS ABOUT 9 POUNDS



THE OIL PASSES THROUGH CURRENTS OF AIR COMING BOTH FROM THE OUTSIDE CONE AND THROUGH THE CENTER

it is claimed that once installed it demands little or no attention except for exterior adjustment of the oil and air lines.

Chills Should Be Dry but Not Overheated

By James Thomas

On page 907, November 15 issue of THE FOUNDRY I read a question and answer touching on the problem why small chilled roll molds sometimes explode. Some years ago while working at a steel plant in the Chicago district I had a similar experience and had tried everything suggested in an effort to determine the exact cause of the trouble. Eventually, I found that too much importance was attached to the necessity of heating the chills before closing the mold. I observed that this practice caused more damage than where the chills were closed cold. Warm cores placed in a mold with a cold chill caused the chill to *sweat*. In either case steam was developed in the mold and just before the iron showed in the riser the explosion occurred.

Finally, having satisfied myself of the cause I applied the remedy which was nothing but insistance that the chills and cores should be perfectly dry and not too warm when placed in the mold. In addition to observing this precaution I applied a thin shellac to both chills and central shaft and experienced no further trouble. The incident outlined happened about 20 years ago and since that time I have made similar castings in various places. I have followed the same practice and have had no trouble. Shellac prevents the moisture from collecting on the face of the chill or the core. It also burns off readily and leaves no more of a carbon deposit than common black oil.

Add Foundry Fractions

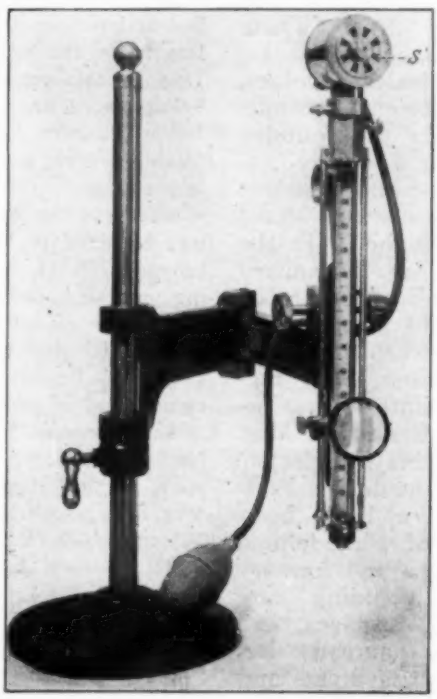
By F. B. Jacobs

In the December 15 issue of THE FOUNDRY, page 988, M. E. Duggan gives a method for patternmakers to follow in adding common fractions. While Mr. Duggan's method will give accurate results, the process involved is too lengthy. In adding fractions, patternmakers can employ the method used by machinists and toolmakers to advantage. Taking the fractions Mr. Duggan mentions, 12 15/16, 12 15/16 and 12 3/16, they should be set down in decimals, as follows:

12.9375
12.9375
12.3125

38.1875

For finding the decimal equivalents of fractional parts of one inch, tables are published in reliable handbooks. These tables, printed on small cards, often are distributed as advertising matter, so that it is a simple matter for the patternmaker to procure a copy.



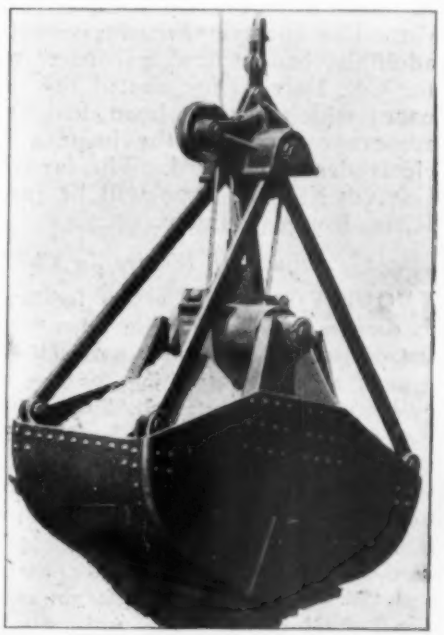
DUST SCREEN *S* HAS BEEN ADDED TO HARDNESS TESTING INSTRUMENT

Modifies Instrument for Testing Hardness

Modifications of the Shore hardness testing instrument have been made by the Shore Instrument & Mfg. Co., Jamaica, N. Y., with a view to increasing the flexibility of the operating mechanism and increasing the life of the instrument. A special fine screen, shown at *S* in the accompanying illustration, has been added to prevent dust from entering the operating mechanism. The leather operating piston formerly used has been replaced by one of tungsten steel, and the rigid adjustment of the hammer hook mechanism has been replaced by a flexible adjustment. Besides being flexible this adjustment is said to prolong the life of the glass tube. Also, the hammer hooks have been provided with shock shoulders to eliminate breakage or disalignment of these parts.

New Clamshell Bucket

The Brown Hoisting Machinery Co., Cleveland, recently has added a new bucket to the extensive line already manufactured. The bucket shown in the accompanying illustration has a capacity of ¾-yard of material, but the same design is made up in 1-yard, 1½-yard and 2-yard sizes. It is claimed that this clamshell is a powerful digger. It is provided with manganese steel digging edges which easily can be replaced when worn. One of its emphasized features is that it is made up of few parts and these parts are easily accessible so that if repairs are necessary they can be made right on the job. All the bearings are lined with bronze bushings and it is stated that the aim of the designers and manufacturers throughout has been to reduce wear to a minimum.



THE DIGGING EDGES ARE REINFORCED WITH MANGANESE STEEL STRIPS

Seasonal Dullness Obscures Outlook

Slightly Better Prospects Forecast for Equipment Manufacturers—Electric Furnaces Are Sold—More Repair Parts Being Ordered—Some Buying Has Been Postponed for the Present

MANY of the equipment firms see indications of improvement in their various lines as shown by inquiries and a few sales. While this improvement is at present only slight it gives some relief from the extreme dullness of the past year. One firm is encouraged by a large increase in orders for repair parts even though its sales are small. Verne E. Minich, president of the American Foundry Equipment Co., and now serving his third term as president of the Foundry Equipment Manufacturers' association, in an interview published in the *Daily Metal Trade* Dec. 16, pointed to the fact that stocks of necessaries are low on both jobbers' and dealers' shelves, prices deflated, and labor in a different attitude. From these and other conditions in the foundry industry Mr. Minich concludes that a steady improvement will be maintained in the equipment line until a large volume of business, which will have to be at a low margin of profit, is reached. In the Cleveland district the principal sales are to sanitary and radiator works. The Foundry Equipment C reports a few sales of core ovens to foundries in the East, but little has been done recently in this district in the sale of molding machines. One machine was sold by the Hill & Griffith Co., Cincinnati, acting as agents for the Berkshire Mfg. Co., Cleveland. A number of contracts for electric furnaces and equipment have been made by Philadelphia firms. F. J. Ryan & Co. have been awarded the contract by the city of Philadelphia for all the equipment in the new forge and foundry shops of the water department, including core ovens, brass melting furnaces, lead furnaces, and heat treating furnaces. The same company has also received contracts for oil-burning systems and furnaces from the U. S. Cast Iron Pipe & Foundry Co. The Electric Furnace Construction Co., Philadelphia, has secured an order from the Ford Motor Co., Detroit, for one of the largest electric furnaces which has yet been designed. The kilowatt-ampere capacity of the furnace is to be 9000, six electrodes being used. The furnace which is of the Greaves-Etchells type will be installed in the new River Rouge foundry.

Attitude of Waiting In Chicago District

INQUIRY as well as orders for foundry equipment and supplies is as slow as in other lines, as the year ends and dealers find consumers not in the mood to buy. The general attitude of waiting for the new year is plainly evidenced and as a result, business is quieter than was the case a month ago. Some preparations are being made for building for additions or betterments, which will become evident during the next few weeks or months, but at present these are largely on paper. Since railroad buying stopped a fortnight ago hopes of foundries that castings contracts would follow have been disappointed, and the expected business has not materialized. The National Engineering Co. recently shipped two large sand mixers, one to Toledo and one to Detroit, and has several other prospects which seem likely to let contracts shortly. No contract for the structure of the Haskell & Barker foundry at Michigan City, Ind., has yet been let, and some delay may be experienced before this becomes an active project.

Sales of Cranes Reported

WHILE demand for flasks, pattern mounting compounds, and molding machines is being fairly well maintained, indicating that jobbing foundries are receiving new contracts from time to time, the situation in the eastern foundry equipment market as a whole is slightly less active than it was a fortnight ago. This is attributed largely to the approaching holiday and inventory season. Due to this reason also shipment on some orders now being placed are to be defered for a month or six weeks. In no case of late has business involved any especially sizable orders; nor have there been any inquiries of special importance.

Although the New York-New Jersey tunnel commission was expected to issue specifications to general contractors around Dec. 15, no action has yet been taken, but is being expected daily. Inquiry for foundry equipment by the board of education of New York City, which has been anticipated by sellers, has also failed to materialize thus far. Export inquiry is being confined to single machines, and is small in the aggregate.

Among recent buyers are the Hecla Iron Works, Brooklyn, which closed on a 2-ton electric crane, with 44-foot span, to the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., and the Wheeling Mold & Foundry Co., Wheeling, W. Va., which bought a 15-ton electric crane, with a 40-foot span, from the Champion Crane & Engineering Co., Kenton, O.

Many Inquiries From All Sections

THE inventory and holiday season combined, made the latter part of December exceedingly dull in Pittsburgh foundry equipment circles. One noteworthy feature of the market, however, is the large number of inquiries for molding machines that are current fom all sections of the country including Brooklyn, N. Y., and Norfolk, Va. The American Radiator Co. is understood to be interested in molding machines, as is the American Locomotive Co. and other locomotive builders. The American Locomotive company shortly will place two or three more orders for molding machines for various plants. This company now is investigating sand conveying machinery and until this matter is decided, further purchases of molding machines are held in abeyance since the arrangement of the latter depends upon the sand machinery installations. One Pittsburgh foundry equipment seller states that practically the only activity it notices is in shipping out orders received in November and the fore part of December since latterly orders have been few and far between. Another reports that no unfilled orders for flasks, wheelbarrows and similar foundry equipment are on the books and no inquiries are before it, creating a gloomy outlook for the immediate future. Others report plenty of inquiries for core ovens, sandmixing and sandcutting equipment, but state that all buying is indefinitely postponed for the present. During the last half of December many foundries suspended shipment on

pig iron contracts until some time in January so that the figures would not appear in their inventories, and by the same token have curtailed their demands for foundry equipment. A few sellers of foundry machinery believe that until business improves and demand is brought more in line with excess casting capacity, equipment sales will be practically negligible. An Irwin, Pa., foundry recently purchased washer and tumbling barrel equipment as well as a screen for drying castings, but since that time has been out of the market. A few inquiries are out for electric melting and annealing furnaces, mostly from a distance, some of the brass foundries being interested in such outfits. Sales of cranes to foundries are rare at present although a large number of inquiries for hoists are before makers. The Sharpsburg Foundry Co., however, has purchased one each 5 and 10-ton Shaw cranes and the Wyatt Metal & Boiler Works, Dallas, Texas, closed on the third crane it has purchased from the Pittsburgh Crane & Equipment Co., Sharpsburg, Pa., taking a 10-ton electric crane.

What the Foundries Are Doing

Activities of the Iron, Steel and Brass Shops

Erection of a foundry building is planned by the Charter Oak Engine Co., Sterling, Ill.

The Lynn Iron Foundry, Inc., Lynn, Mass., has a permit to erect a foundry building on Broad street, 53 x 92 feet.

Contracts have been let for the erection of a factory building and foundry at Ecorse, Mich., by the General Forging Corp.

The plant of the West Michigan Steel Foundry Co., Muskegon, Mich., recently was damaged by fire.

The Buckeye Castings Co., Lima, O., recently increased its capital stock from $25,000 to $50,000.

The Standard Brake Shoe & Foundry Co., Pine Bluff, Ark., is reported planning some improvements to its plant.

The Pacific Stove & Stamping Co., Tacoma, Wash., plans to rebuild the part of its plant which was recently damaged by fire.

The Block Brass Foundry Co., Inc., Oakland, Cal., has enlarged its plant by the erection of a bay, 50 x 300 feet, which is equipped with a cupola.

The Ann Arbor Implement Co., Ann Arbor, Mich., has been organized to manufacture farm implements, machinery, etc., with a capital stock of $50,000, by Dwight A. Baylis and others.

Capitalized at $10,000, the Riverside Bronze & Aluminum Co., New Haven, Conn., recently was incorporated by Thomas E. Hyve, Harold S. Brown and John F. Sturry.

The Pittsburgh Nipple & Mfg. Co., Pittsburgh, has been incorporated with $25,000 capital stock, by George B. Shaw, Fred Manns, George A. Manns and Ellsworth Jordan.

The Charlotte Stove Co., Charlotte, N. C., recently was incorporated with $15,000 capital stock, by J. B. Groome, George L. and F. E. Lee.

Capitalized at $25,000, the J. L. Collins Machine Co., Haverhill, Mass., recently was incorporated to operate a foundry and machine shop, by Jay L. Collins, M. D. Collins and Herman C. Leschke.

The Marion Foundry Corp., Marion, Ind., has changed its place of business from Marion to Auburn, Ind., and has decreased the number of directors from six to five and its capital stock from $100,000 to $56,500.

The Chicago Core Compound Co., 302 Marquette building, Chicago, has been incorporated to manufacture foundry supplies, by W. W. Welch, Thomas C. Loveless and William A. Herron.

Erection of a plant at Highland Park, Mich., is planned by the Detroit Marine Aero Engine Co., Detroit, which was organized recently by A. A. Schantz, Otto F. Barthel, Garfield A. Wood, J. Lee Barrett and Fred R. Still.

The Western Foundry & Furnace Co., 3002 South Chandler street, Tacoma, Wash., plans to establish a department for the manufacture of electrical specialties. A. Z. Love is president of the company.

The Fuel Utilization Corp., New York, furnaces, boilers, etc., recently was incorporated with $1,200,000 capital stock, by C. Churchill, P. N. Hayes and W. H. Barker. The company is represented by Randall & Larson, 149 Broadway.

Enlargement of the scope of production of the International Steel Products Co., Hartford, Wis., has been announced. The company has been manufacturing gas engine silencers but now is making a wide variety of products.

The Morgan Pump & Motor Corp., New York, recently was incorporated with a capital stock of $100,000, by J. J. Matthews, J. L. Johnson and J. L. Cummings. The company is represented by M. V. McVeigh, 32 Liberty street.

The Weekes Engineering Corp., Welland, Ont., plans to establish a plant for the manufacture of boilers, etc. L. R. Weekes is president of the company. The plant of the Welland Machine & Foundries, it is understood, will be taken over.

The National Cast Iron Pipe Co. has closed a lease for 50 per cent additional space at its warehouse, 3635 South Ashland avenue, Chicago. The warehouse was established a year ago and its activities have been such that additional space is necessary.

M. J. Finn, J. B. Rice and W. V. Carnegie, all of Pittsburgh, recently were named as the incorporators of the M. J. Finn Pump Mfg. Co., which was incorporated under the laws of Delaware with a capital stock of $200,000. The company is represented by the Capital Trust Co., Dover, Del.

The Southbridge Foundry Co., Southbridge, Mass., has awarded a contract for the erection of a 1½-story building to cost about $30,000. The company recently was incorporated with $30,000 capital stock to operate a foundry and machine shop, by Arthur A. Allard, Frank S. Mills and M. E. Mills.

Deep-well pumps are to be manufactured by the Universal Pump & Mfg. Co., which was recently incorporated at Redding, Cal., with a capital stock of $50,000. The company will operate a foundry and machine shop. Directors of the new organization are I. J. Johnson, S. F. Henderson and J. W. Carter.

The Anderson Stove Co., a $5000 organization recently incorporated, will operate a stove factory in the old Frazer plant in North Anderson, Ind. The industry will employ 70 men at the start and will begin work about Jan. 10. Kitchen ranges will be made for a Chicago company. John Keeke, of Indianapolis, is a director of the company.

Plans are under way for the operation of a foundry at New Cumberland, W. Va., by the Resistant Alloy Casting Co., which was recently organized with a capital stock of $10,000 and incorporated under the laws of Delaware. The company will manufacture gray-iron castings. The plant, which it will occupy, has been idle for several years. The new company was organized by LeRoy Ault, of Steubenville, O., and D. B. McIntosh, of East Liverpool, O.

Operation of the Stockton Iron Works, Stockton, Cal., under the name of the Terminal Iron Works, is to be carried on by Harry W. Fawke, formerly superintendent of hull construction of the Moore Shipbuilding Co., Oakland, Cal. Earl McKarley, also formerly of the Moore company, will be associated with Mr. Fawke in the project. Several acres of land have been leased from the Southern Pacific Co. and a plant is to be erected for general ship repair work as well as structural work.

Brass and aluminum castings will be manufactured by the National Brass Foundry, Inc., which recently was organized at Milwaukee, with a capital stock of $10,000, by John Jacoby, Paul Daehling and William N. Leininger. Messrs. Jacoby and Daehling are members of Jacoby-Daehling, Ltd., operating a pattern and diemaking plant at 758-760 South Pierce street, Milwaukee. Mr. Leininger is an experienced brass foundry operator having been for several years general foreman of the Milwaukee Die Casting Co.

An electric-furnace department has been established by William Swindell & Bros., Jenkins Arcade building, Pittsburgh, under the direct supervision of Frank W. Brooke, former vice president and chief engineer of the Electric Furnace Construction Co., Philadelphia. The new department will be devoted to the design and sale of electric furnaces for melting steel, gray iron and nonferrous metals; and also electric heating furnaces. A license to operate under patents for nickel-chromium electric resistance elements has been granted the company.

Increased orders for railroad castings have resulted in the reopening of the Elm street foundry of the Western Malleable Co., Beaver Dam, Wis. The company operates three large shops in Beaver Dam. One is devoted to light castings for the automobile and farm implement industries and the other two specialize in railroad work. In recent months the company has made important changes to provide for the use of pulverized coal as fuel. It is now building a coal pulverizing plant between the Elm street and South street foundries to serve

all three shops by a pipe line system for conducting powdered fuel to boilers, furnaces and ovens by air pressure.

A new $60,000 foundry has been completed at Washington avenue and Blake street, Indianapolis, by the C. & A. Potts Co. This foundry is said to be one of the finest and most completely equipped small foundries in Indiana and will make it possible for the company to reach a daily maximum output of about 26 tons. In connection with the foundry, there is being erected a 2-story brick pattern storage building, 45 x 100 feet. In the new foundry and the one being used about 125 men will be employed. A general line of semisteel and clay working machinery will be manufactured.

Announcement was made recently of a change in one of the important industries at Brazil, Ind., in which Don M. Crawford retired from the Crawford-Macbeth Co., disposing of his interests in the machine and foundry business to his partner, Frank A. Macbeth. The business will be conducted in the future under the name of the F. A. Macbeth Co. The Crawford-Macbeth Co. was organized and began business May 1, 1918, when Messrs. Crawford and Macbeth took over the interests of the William M. Shaw Co. in the machine shops and foundry. During this time the company has grown and has been doing a large volume of business which now includes mine pumps. The company ships its products throughout the coal fields of the United States as well as some foreign countries, having made shipments as far as Borneo. The dissolution also affects the Service Foundry Co., which is operated in connection with the machine shops and which will be continued under the same name, manufacturing a line of pumps, stove and gray iron castings. Mr. Crawford has disposed of his interests because of poor health, but for the present he will continue as sales manager.

New Trade Publications

TRUCKS—The Stuebing Truck Co., Cincinnati, is circulating two large folders in which lift trucks are described and illustrated. One folder describes seven different molds. Specifications and other data are given.

CHUCKS—The Skinner Chuck Co., New Britain, Conn., has published a 52-page illustrated booklet in which lathe, drill and planer chucks and vises are described and ilustrated. Specifications and complete data are given.

SAND BLASTING—The Pangborn Corp., Hagerstown, Md., has prepared a 4-page illustrated folder in which attention is called to sandblasting equipment for the manufacturing plant, small foundry or shop doing work in a limited volume.

HEATERS—The McCann-Harrison Co., Cleveland, has published a 4-page illustrated bulletin in which direct fired heaters for hot blast, or unit heating of buildings, drying, etc., are described and illustrated. Several installations of this equipment are included in the illustrations.

CRANES—Crawling tractor cranes are described and illustrated in an 8-page illustrated bulletin recently issued by the Industrial Works, Bay City, Mich. The booket contains complete descriptions, specifications, etc., of the various types of cranes, and the illustrations show them engaged in various operations.

BAND SAW—The Clark Tool Works, Inc., Belmont, N. Y., has published a 12-page illustrated booklet in which a compound metal cutting band saw is described and illustrated. The machine uses a band saw 1 inch wide and 15 feet 6 inches long, and cuts on both sides at the same time; cutting down on the right hand side and up on the left. Specifications and other data are given.

MOTOR DRIVE—The Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., is circulating a 4-page leaflet in which electric motor drive for power pumps is described and illustrated. Among the claimed advantages of motor drive as pointed out in the leaflet are greater reliability, small space requirements, freedom from noise and vibration, greater flexibility as to location, greater ease of control, and less operating attention.

ELECTRIC HOIST—The Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., is circulating an illustrated folder in which a small electric hoist is described and illustraded. The hoist is made in capacities of 1000 and 2000 tons. It is equipped with a motor especially designed for hoisting service and can be furnished for alternating or direct current. The leaflet lists the various uses to which the hoist is adapted.

PUMPS—The Chicago Pneumatic Tool Co., New York, has published a 28-page illustrated booklet in which dry vacuum pumps, steam, belt and motor-driven, are described and illustrated. These pumps are said to be particularly suitable for service in sugar houses, canneries, gasoline extraction plants, chemical works and power plants.

WELDING TORCH—The Davis-Bournonville Co., Jersey City, N. J., is circulating a small 4-page leaflet in which a welding torch and carrying case outfit for garages and small machine shops are described and illustrated. This carrying case outfit consists of a torch, welding tips, decarbonizing tube, oxygen regulator, oxygen hose, acetylene hose, sparklighter, colored glasses, torch wrench and a regulator wrench.

FOUNDRY EQUIPMENT—The J. S. McCormick Co., Pittsburgh, is circulating a 22-page illustrated booklet in which general foundry equipment is described and illustrated. This includes cupolas, blowers, ladles, riddles, cranes, flasks, hoists, molding machines, tumbling mills, core ovens, etc. In addition to the booklet the company has published a 4-page folder in which attention is called to ladle pouring devices, electric tools, oil burning foundry equipment, etc.

MOTORS—The Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has published a leaflet in which motors for elevator service are described and illustrated. These motors are for both direct and alternating current circuits. Direct current motors are furnished in several classes and squirrel cage and slip ring alternating current motors are supplied in all capacities required. Information on how to determine the selection of an elevator motor is given in the circular.

ENGINE—The Hadfield-Penfield Steel Co., Bucyrus, O., has published a 24-page illustrated booklet in which a fuel oil engine of the horizontal type is described and illustrated. This engine is of the high-compression type operating on the diesel principle. It is not an explosive engine and consequently no ignition apparatus is necessary. It operates on the two-stroke cycle. Engines of this type are adapted for any power service, including service where close regulation is necessary. Complete details are given in the booklet.

INDUSTRIAL BUILDINGS—Mills, Rhines, Bellman & Nordhoff, Toledo, are circulating an illustrated booklet in which numerous modern factory buildings, which they have designed and constructed, are shown. Some of the plants illustrated with interior and exterior view are: The Bunting Brass & Bronze Co., Toledo, O.; the Mather Spring Co., Toledo, O.; the Toledo Milling Machine Co., Toledo, O.; Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.; the Auburn Automobile Co., Auburn, Ind., and the Ross Gear & Tool Co., Lafayette, Ind.

ELECTRIC FURNACE—The Electric Furnace Co., Alliance, O., has published a large folder containing illustrations of actual installations of electric furnaces which it manufactures. Some of the furnaces illustrated are at the plants of the Dayton Engineering Laboratories, Dayton, O.; Atlas Brass Foundry Co., Columbus, O.; West Virginia Metal Products Corp., Fairmount, W. Va.; Nolte Brass Co., Springfield, O.; Standard Sanitary Mfg. Co., Louisville, Ky.; Regent Brass Foundry Co., Marysville, O.; Sperry Gyroscope Co., Brooklyn, N. Y., and numerous others.

FOUNDRY EQUIPMENT—The Sterling Wheelbarrow Co., Milwaukee, has published a large 104-page illustrated book in which foundry equipment and supplies are described and illustrated. This is one of the most elaborate catalogs of its kind and is complete with specifications and other data of the equipment described. The booklet, which is printed on heavy wax paper, is divided into five sections. The first describes rolled steel flasks; the second, flask pins; the third, foundry barrows; the fourth, foundry trucks, and the fifth general foundry specialties, including gate sticks, skim gates, sprue boxes, jackets, rolled steel upsets, etc.

SWITCH—The Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has published a leaflet in which an enclosed type float switch is described and illustrated. This type of switch is used on motor operated pumps to maintain a water level in open tank, reservoir, or sump systems, and to prevent the water from rising above a predetermined level. On open tanks and reservoir systems the motor is automatically started when the water reaches the low level and stoppd when the high point is reached. On sump systems the action is just the reverse; the motor is automatically stopped at the low level and started at the high point. Other details are given.

STEEL SASH—The Truscon Steel Co., Detroit, has published an 80-page illustrated booklet, which is one of the most complete works on steel window sash that has been published. Standard dimension tables, architectural details, specifications and more than 20 pages of illustrations feature the booklet. Distinctive features of the sash are pointed out and installation details given. The booklet is divided into five parts, each devoted to describing some particular type of sash. The first part gives a general outline of the features; the second section is devoted to continuous types; the third to torsion type for pivoted sidewall sash and tension type for continuous sash; the fourth to counterbalanced types and the fifth to partitions and doors.

ROTATORS—The Sullivan Machinery Co., Chicago, has published an illustrated booklet in which a rock drilling machine is described and illustrated. It is adapted for use in all kinds of drilling work, including the removal of cores from castings, blockading and cutting hitches; shaft sinking and a great variety of down hole drilling, drifting, stoping and light tunneling work in hard and soft rock, ore and coal, in quarries and mines, in road grading, in sewer trenches and in heavy work. The drill weighs from 29 to 40 pounds and is equipped with automatic steel rotation. It is built in air and steam types and may be used as a hand tool or on a mounting. Full details are given in the booklet, which are augmented with numerous illustrations.